

AD-A076 362

LOS ALAMOS SCIENTIFIC LAB N MEX

F/G 4/2

ACTIVITIES OF THE SPECIAL WEATHER ADVISORY SERVICE. OPERATION T--ETC(U)

JUN 52 C A SPOHN

UNCLASSIFIED

AEC-WT-552

NL

1 OF 1  
AD  
A076362



PHOTOGRAPH THIS SHEET

AD A 076362

DTIC ACCESSION NUMBER



LEVEL



INVENTORY

AEC

WT-552

DOCUMENT IDENTIFICATION

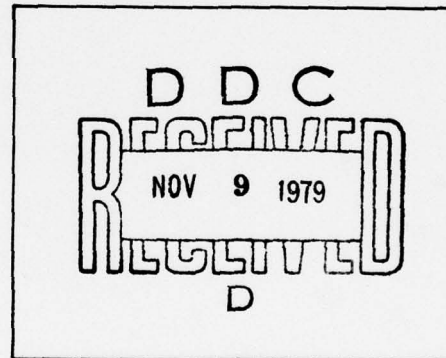
DISTRIBUTION STATEMENT A

Approved for public release;  
Distribution Unlimited

DISTRIBUTION STATEMENT

ACCESSION FOR	
NTIS	GRA&I <input checked="" type="checkbox"/>
DTIC	TAB <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
Per Htr. on file	
BY	
DISTRIBUTION /	
AVAILABILITY CODES	
DIST	AVAIL AND/OR SPECIAL
A	

DISTRIBUTION STAMP



DATE ACCESSIONED

DATE RECEIVED IN DTIC

PHOTOGRAPH THIS SHEET AND RETURN TO DTIC-DDA-2

293920V

**SECRET**  
**SECURITY INFORMATION**

**UNCLASSIFIED**

This document consists of 64 pages

No. 44 of 110 copies, Series A

**Report to the Test Director**

## **ACTIVITIES OF THE SPECIAL WEATHER ADVISORY SERVICE**

**Operation Tumbler-Snapper**

by

Clifford A. Spohn

Lt Col, USAF

Los Alamos Scientific Laboratory  
University of California  
November 1952

**RESTRICTED DATA**

This document contains restricted data as defined in the Atomic Energy Act of 1946. Its transmittal or the disclosure of its contents in any manner to an unauthorized person is prohibited.

Statement A  
Approved for public release  
Distribution unlimited.

1-2

**SECRET**  
**SECURITY INFORMATION**

**UNCLASSIFIED**

**SECRET — SECURITY INFORMATION**

UNCLASSIFIED

## **ABSTRACT**

Certain weather advisory functions were delegated to the Group H-6 (LASL) Weather Section during test activities at the Nevada Proving Grounds. The techniques utilized in performing these functions are outlined, and the actual advisories, forecasts, and analyses issued are made a matter of record. There is some discussion as to the consistency of certain phases of the advisory services and indications of future study and amplifications of the results.

UNCLASSIFIED

**SECRET — SECURITY INFORMATION**

**UNCLASSIFIED**

~~SECRET - SECURITY INFORMATION~~

## CONTENTS

	Page
ABSTRACT . . . . .	3
1 GENERAL . . . . .	7
1.1 Preshot Functions . . . . .	7
1.2 Postshot Functions . . . . .	7
2 FALL-OUT FORECASTS AND PLOTS . . . . .	7
2.1 Tumbler-Snapper 1 . . . . .	8
2.2 Tumbler-Snapper 2 . . . . .	8
2.3 Tumbler-Snapper 3 . . . . .	8
2.4 Tumbler-Snapper 4 . . . . .	8
2.5 Tumbler-Snapper 5 . . . . .	8
2.6 Tumbler-Snapper 6 . . . . .	8
2.7 Tumbler-Snapper 7 . . . . .	9
2.8 Tumbler-Snapper 8 . . . . .	9
2.9 Summary . . . . .	9
3 CLOUD-HEIGHT FORECASTS AND DETERMINATIONS . . . . .	9
3.1 Forecast Techniques . . . . .	9
3.2 Determination Techniques . . . . .	9
3.3 Results . . . . .	10
4 CAA AIRSPACE CLOSURES. . . . .	10
4.1 Form of the Closure Plan . . . . .	10
5 CLOUD TRAJECTORIES . . . . .	11

## ILLUSTRATIONS

1 Fall-out Forecast, Tumbler-Snapper 1 . . . . .	12
2 0600 Fall-out Plot, Tumbler-Snapper 1 . . . . .	13
3 Fall-out Forecast, Tumbler-Snapper 2 . . . . .	14
4 0600 Fall-out Plot, Tumbler-Snapper 2 . . . . .	15
5 0800 Fall-out Plot, Tumbler-Snapper 2 . . . . .	16
6 1000 Fall-out Plot, Tumbler-Snapper 2 . . . . .	17
7 1300 Fall-out Plot, Tumbler-Snapper 2 . . . . .	18
8 Fall-out Forecast, Tumbler-Snapper 3 . . . . .	19

~~SECRET - SECURITY INFORMATION~~

**UNCLASSIFIED**

# SECRET — SECURITY INFORMATION

## ILLUSTRATIONS (Continued)

	Page
9 0600 Fall-out Plot, Tumbler-Snapper 3 . . . . .	20
10 0800 Fall-out Plot, Tumbler-Snapper 3 . . . . .	21
11 1000 Fall-out Plot, Tumbler-Snapper 3 . . . . .	22
12 Fall-out Forecast, Tumbler-Snapper 4 . . . . .	23
13 0600 Fall-out Plot, Tumbler-Snapper 4 . . . . .	24
14 1000 Fall-out Plot, Tumbler-Snapper 4 . . . . .	25
15 Fall-out Forecast, Tumbler-Snapper 5 . . . . .	26
16 0300 Fall-out Plot, Tumbler-Snapper 5 . . . . .	27
17 Preliminary Fall-out Forecast, Tumbler-Snapper 6 . . . . .	28
18 Fall-out Forecast, Tumbler-Snapper 6 . . . . .	29
19 0200 Fall-out Plot, Tumbler-Snapper 6 . . . . .	30
20 0400 Fall-out Plot, Tumbler-Snapper 6 . . . . .	31
21 Fall-out Forecast, Tumbler-Snapper 7 . . . . .	32
22 0300 Fall-out Plot, Tumbler-Snapper 7 . . . . .	33
23 Fall-out Forecast, Tumbler-Snapper 8 . . . . .	34
24 0300 Fall-out Plot, Tumbler-Snapper 8 . . . . .	35
25 Forecast and Computed Cloud Heights . . . . .	36
26 Cloud Growth Curve, Tumbler-Snapper 1 . . . . .	37
27 Cloud Growth Curve, Tumbler-Snapper 2 . . . . .	37
28 Cloud Growth Curve, Tumbler-Snapper 3 . . . . .	38
29 Cloud Growth Curve, Tumbler-Snapper 4 . . . . .	39
30 Cloud Growth Curve, Tumbler-Snapper 5 . . . . .	40
31 Cloud Growth Curve, Tumbler-Snapper 6 . . . . .	41
32 Cloud Growth Curve, Tumbler-Snapper 7 . . . . .	42
33 Cloud Growth Curve, Tumbler-Snapper 8 . . . . .	43
34 CAA Closure, Tumbler-Snapper 1 . . . . .	44
35 CAA Closure, Tumbler-Snapper 2 . . . . .	45
36 Change in CAA Closure, Tumbler-Snapper 2 . . . . .	46
37 CAA Closure, Tumbler-Snapper 3 . . . . .	47
38 CAA Closure, Tumbler-Snapper 4 . . . . .	48
39 CAA Closure, Tumbler-Snapper 5 . . . . .	49
40 CAA Closure, Tumbler-Snapper 6 . . . . .	50
41 CAA Closure, Tumbler-Snapper 7 . . . . .	51
42 CAA Closure, Tumbler-Snapper 8 . . . . .	52
43 Change in CAA Closure, Tumbler-Snapper 8 . . . . .	53
44 Cloud Trajectories, Tumbler-Snapper 1 . . . . .	54
45 Cloud Trajectories, Tumbler-Snapper 2 . . . . .	55
46 Cloud Trajectories, Tumbler-Snapper 3 . . . . .	56
47 Cloud Trajectories, Tumbler-Snapper 4 . . . . .	57
48 Cloud Trajectories, Tumbler-Snapper 5 . . . . .	58
49 Cloud Trajectories, Tumbler-Snapper 6 . . . . .	59
50 Cloud Trajectories, Tumbler-Snapper 7 . . . . .	60
51 Cloud Trajectories, Tumbler-Snapper 8 . . . . .	61

## SECRET — SECURITY INFORMATION

# ACTIVITIES OF THE SPECIAL WEATHER ADVISORY SERVICE

### 1 GENERAL

The Weather Section of the Health Division of the Los Alamos Scientific Laboratory was charged with providing certain specialized weather advisory service for the Advisory Panel during Operation Tumbler-Snapper. In addition, a very close liaison was maintained with the Radiological-Safety (Rad-Safe) Group on those items which were of especial interest to that organization. The same functions were performed as in Operation Buster-Jangle, with the addition of the analysis of cloud trajectories, formerly carried out by the AFOAT meteorologist. The specific functions are as follows:

#### 1.1 Preshot Functions

1. Preparation of fall-out forecasts and plots
2. Forecasts of maximum cloud height
3. Determination of necessary airspace closure for CAA

Forecasts of cloud trajectory, which would normally fall into this group, were made by the Air Weather Service forecast team at Mercury Weather Central, under the direction of Maj DeWitt Morgan, chief forecaster.

#### 1.2 Postshot Functions

1. Preparation of additional fall-out plots, as required
2. Computation of cloud heights
3. Recommendations for changes in CAA airspace closure
4. Analysis of cloud trajectories

Postshot analysis of fall-out was also carried out, but, since this was frequently completed at a considerable time after the shot, it is not considered an integral part of the test advisory service. A separate report is being prepared by the author on the meteorological postshot analysis of fall-out and the relative accuracy of the fall-out forecasts and plots indicated by it.

### 2 FALL-OUT FORECASTS AND PLOTS

Forecast fall-out patterns were prepared for the briefings given to the advisory panel at 2000 local time on D-1 day. These forecasts were based on the wind forecast for the target area at shot time, as prepared by the Mercury Weather Central forecast team. (See Appendix A to "Activities of the Special Weather Advisory Service" for Operation Buster-Jangle for description of technique of preparation of fall-out forecasts.) In addition, fall-out plots were prepared based on the last wind sounding made at the Control Point prior to shot time. These

## SECRET — SECURITY INFORMATION

early morning preshot plots and the postshot plots were primarily for the use of Maj N. M. Lulejian, controller in the off-site monitoring section of the Rad-Safe Group, in positioning his monitors.

The various fall-out forecasts and plots are shown in Figs. 1 to 24. Discussion of the patterns for each individual shot follows.

### 2.1 Tumbler-Snapper 1 (Figs. 1 and 2)

The briefing forecast indicated fall-out to the southeast. The fall-out plot prepared from the 0600 PST wind sounding showed the main fall-out belt as having shifted to the east-northeast. Low-level fall-out (i.e., fall-out originating at low levels, in the stem) was widely dispersed through the north, west, and southwest but moving away from zero point very slowly except toward the southwest.

### 2.2 Tumbler-Snapper 2 (Figs. 3 to 7)

The briefing forecast again called for fall-out to the southeast. The fall-out plots prepared from the 0600, 0800, 1000, and 1300 PST winds show fall-out generally in the south and southwest sectors. The most notable change is the decrease in the speed of horizontal movement of the fall-out during the day.

### 2.3 Tumbler-Snapper 3 (Figs. 8 to 11)

The forecast prepared from the briefing winds showed the fall-out sector lying to the south-southeast. The 0400 and 0800 PST plots show the main fall-out sector remaining in the south-southeast, but with the low-level fall-out swinging more and more into the west. By 1000 PST the plot shows the low-level fall-out occurring to the northwest, while the main fall-out sector now lies in the southeast. This large shift in the low-level fall-out sector is again accompanied by a marked decrease in the horizontal speed of the fall-out, as it was during Tumbler-Snapper 1.

### 2.4 Tumbler-Snapper 4 (Figs. 12 to 14)

The briefing fall-out forecast indicated that fall-out would occur in the northeast quadrant, with the primary fall-out lying to the east-northeast. The fall-out plot prepared from the 0600 PST wind data indicated a shift of the primary fall-out to due east, but by the 1000 PST wind data the primary zone again lay in the east-northeast. The horizontal movement of the upper-level fall-out was somewhat less on the 0600 and 1000 PST fall-out plots than on the briefing forecast.

### 2.5 Tumbler-Snapper 5 (Figs. 15 and 16)

The fall-out forecast prepared from the briefing wind forecast showed fall-out occurring to the northeast. The 0300 PDT wind data supported this but with the horizontal movement greatly increased, especially in the lower levels.

### 2.6 Tumbler-Snapper 6 (Figs. 17 to 20)

A preliminary forecast, prepared from the 48-hr wind advisory on D-2 day indicated that the fall-out would lie off to the east-northeast. The briefing fall-out forecast continued the primary fall-out to the east-northeast but showed the low-level fall-out spread widely through the northeast and north. Neither the 0200 PDT nor the 0400 PDT wind data supported this wide dispersion of the low-level fall-out, both showing all fall-out to the northeast.

## SECRET — SECURITY INFORMATION

### 2.7 Tumbler-Snapper 7 (Figs. 21 and 22)

The briefing fall-out forecast indicated a very narrow fall-out sector, lying just west of due north. The fall-out plot prepared from the 0300 PST wind data showed this zone somewhat more widely spread and lying to the north. In addition, the horizontal movement was increased, especially at the higher levels.

### 2.8 Tumbler-Snapper 8 (Figs. 23 and 24)

The forecast of fall-out for the briefing showed the primary fall-out sector lying due west, with low-level fall-out off to the southwest. The wind data at 0300 PDT showed a marked clockwise shift of the whole pattern, with the fall-out sector now lying off to the northwest.

### 2.9 Summary

The primary fall-out patterns (i.e., fall-out occurring from the cloud proper and the upper stem) do not show excessive shifts from the briefing forecasts to the D Day plots, generally less than 45° except in the case of Tumbler-Snapper 8, where the shift is about 60° clockwise. The low-level fall-out patterns, however, show extreme shifts at times, as in Tumbler-Snapper 1 and 3, where the change amounted to 180°. These large shifts were accompanied by a marked decrease in the low-level wind speeds, obviously resulting from the weak gradient type of pressure pattern at low levels which presents the meteorologist with the most difficult problem in forecasting wind direction.

## 3 CLOUD-HEIGHT FORECASTS AND DETERMINATIONS

A forecast of anticipated maximum cloud height was prepared immediately preceding the fall-out forecast and was included in the material presented at the briefing. These cloud-height forecasts were used primarily to determine the levels from which fall-out could be expected and the levels of concern in the CAA airspace closure.

### 3.1 Forecast Techniques

Two techniques were used in making the cloud-height forecasts. For shots with small yields (less than 12 to 15 kt), the forecast was made using a regression equation, derived from the Ranger and Buster-Jangle data, whose independent variables were the bomb yield and an evaluation of the forecasted lapse rate.

In the case of shots with larger yields, the forecast was more subjective. The items of consideration in these cases were the forecasted height of the tropopause and a subjective estimate of the amount of penetration which would be achieved. It is hoped that before the next test series the amount of penetration can also be determined by an objective method.

### 3.2 Determination Techniques

Beginning at 1 min after shot time and continuing at 1-min intervals up to 10 to 12 min, elevation angles to the top of the cloud were read through a theodolite. These were combined with the wind data closest to zero time to determine the cloud height by the following method. An initial cloud height would be determined from the elevation angle. The base line would then be corrected by applying the 1-min cloud drift indicated by the wind flow in the layer through which the cloud was rising. This new base-line distance and the elevation angle would then yield a second approximation. Since these 1-min corrections to the cloud height were rarely in excess of 1500 ft, the second approximation yielded as much accuracy as the method justified.

The errors in the technique were due to the assumptions that wind data taken about 15 miles from point zero, and an hour earlier or later than shot time, represented the wind flow

## SECRET — SECURITY INFORMATION

through which the cloud passed and that the sightings were really made on the top of the cloud. This latter item was of less importance if the cloud moved away from the Control Point, but when the cloud approached the Control Point it became of major importance. In Tumbler-Snapper 3 the cloud moved toward the Control Point to such an extent that within 5 min the elevation readings were no longer valid. The effects of the first assumption are difficult to assess, since no very good idea exists as yet as to how much the actual explosion may disrupt the local air flow, or the time required for the *status quo* to be restored. Nonetheless, it is believed that these results are more accurate than the cloud-height estimates made by the aircraft pilots, who are frequently thousands of feet lower than the cloud top and are basing their estimates on pressure altimeter readings which may be off by several thousand feet at those elevations.

### 3.3 Results

Figure 25 shows the forecast and computed cloud heights for Tumbler-Snapper. (The computed height assigned to Tumbler-Snapper 3 is based on aircraft reports, since the theodolite data became useless within the first 5 min.) The results, assuming these data are correct, are reasonably accurate. For six of the eight shots, the cloud height was forecast to within  $\pm 2000$  ft. In the case of the other two, Tumbler-Snapper 5 and 7, the cloud top was forecast 3000 ft higher than occurred.

Figures 26 to 33 show the individual cloud growth curves as computed from the theodolite and wind data. It is interesting to note the tendency of the cloud to sink after attaining maximum height, as is shown in most of the growth curves.

## 4 CAA AIRSPACE CLOSURES

On the evening prior to each shot a conference was held, immediately following the briefing, to determine the air sectors which would have to be closed to traffic during and after the shot. Participating members in the conference were H. J. Greenleaf, CAA representative, Duncan Curry, Jr., Test Director's representative, Dr. T. L. Shipman and/or T. N. White, of the Health Division, LASL, and Lt Col C. A. Spohn, meteorological advisor. On occasion either Lt Col J. B. Hartgering or Maj N. M. Lulejian of the Rad-Safe Group participated. At this conference an initial closure plan would be determined, based on (1) the forecast cloud trajectory at various levels, (2) the forecast of the height of the cloud top and base, and (3) a dosage computation developed by T. N. White, which considered the wind shear, the rate of turbulent diffusion, the radioactive decay rate, and the bomb yield.

Following shot time this closure plan would be amended as required when the reports of the tracking aircraft, the latest wind data, and the cloud-height computations indicated that items 1 and/or 2 differed markedly from the forecast values. If no changes were initiated by the meteorologist within 2 to 3 hr after shot time, Duncan Curry, Jr., H. J. Greenleaf, and Lt Col C. A. Spohn would meet to verify that no changes were required.

It was, in addition, necessary to ensure that no dangerous contamination should occur to nonparticipating aircraft and personnel and at the same time to disrupt as little as possible the commercial air schedules. Because of the operating techniques of CAA, the philosophy of the conference was always to plan the closure so that changes would be much more likely to release airspace than to close additional airspace, since the former could be done much more rapidly and positively than the latter. This ensured that the first requirement would be met, even if the second could not always be.

### 4.1 Form of the Closure Plan

The closure plan had to be drawn up in such a form that it could be easily administered by the CAA control center at Salt Lake City. The form which was devised as meeting this need most completely is given in the following paragraphs.

## SECRET — SECURITY INFORMATION

(a) *Flash Circle*. A circle, of either 50- or 60-mile radius, center at 37°N, 116°W, closed at all altitudes for a period of several hours which included, but did not bracket, shot time. The flash circle was to ensure no aircraft being close enough to the blast at shot time for the pilot to suffer eye injury.

(b) *Sector*. A pie-shaped wedge, tip at 37°N, 116°W, was marked out to include those elevations and areas of normal outside traffic (i.e., outside the range) in which cloud and debris drift was anticipated while still dangerous. After the first two shots, the sectors were concerned only with the stem cloud.

(c) *Warning Circle*. A circle of sufficient size to include both the flash circle and the sector was laid out centered on some well-known town. This circle was for the convenience of CAA in alerting pilots as to the region through which flight plans needed to be cleared with the control center. It was the only part of the closure plan which was released to the general public by the CAA control center at Salt Lake City.

(d) *High-level Quadrangle (or Triangle)*. Beginning with the fourth shot and continuing thereafter, a high-level quadrangle or triangle was closed to jet and other high-level military traffic for a considerable period (12 to 15 hr). This region was always much larger than the warning circle and covered the region through which the cloud proper was expected to drift while still hazardous. The base of this region was never lower than 26,000 ft and hence was above the level of commercial traffic. Distribution of this notification was handled by the CAA control center at Salt Lake City, who would notify those military airfields handling high-level military traffic.

The closure plans for the various shots of the Tumbler-Snapper series are included as Figs. 34 to 43. The changes to a given closure plan are listed in the figure legends, except where the change was so complex as to require a separate plot.

### 5 CLOUD TRAJECTORIES

Following each shot, a cloud-trajectory analysis was carried out. Appropriate levels were selected to cover the vertical extent of the cloud, within the limits as imposed by the wind data available. For the selected levels, constant-level wind charts were plotted and analyzed at 6-hr intervals (i.e., the intervals at which synoptic wind soundings are made at the various meteorological stations nationwide). The cloud was then moved at each level as indicated by the streamlines and isotachs, assuming that the analyzed field was unchanged during the 6-hr period (taken as 3 hr before and after synoptic time). For this reason the plotted cloud trajectories sometimes show abrupt changes in direction or speed, at the change from one 6-hr period to the next. The trajectories were usually computed for 24 hr, or until the cloud was several hundred miles from the site.

Figures 44 to 51 show the plotted trajectories for the Tumbler-Snapper test series. In Fig. 51 (Tumbler-Snapper 8), two 40,000-ft trajectories are shown. At that level the cloud path moved through a "col" (saddle) area in the wind field in which it was not possible to choose between the alternate paths; hence both possibilities are shown.

SECRET — SECURITY INFORMATION

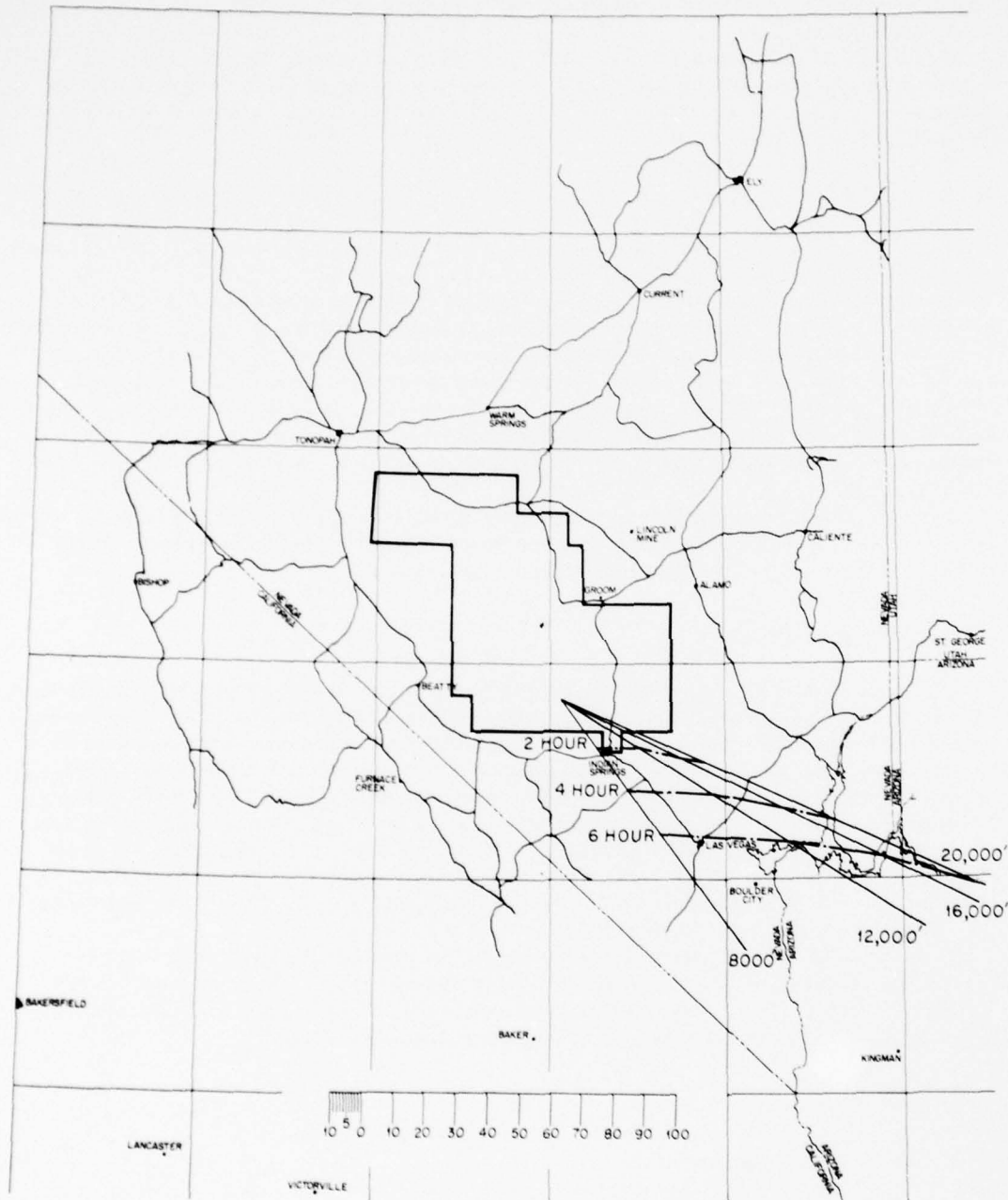


Fig. 1— Fall-out forecast for Tumbler-Snapper 1, prepared from briefing wind forecast at 2000 PST on D-1 day.

SECRET — SECURITY INFORMATION

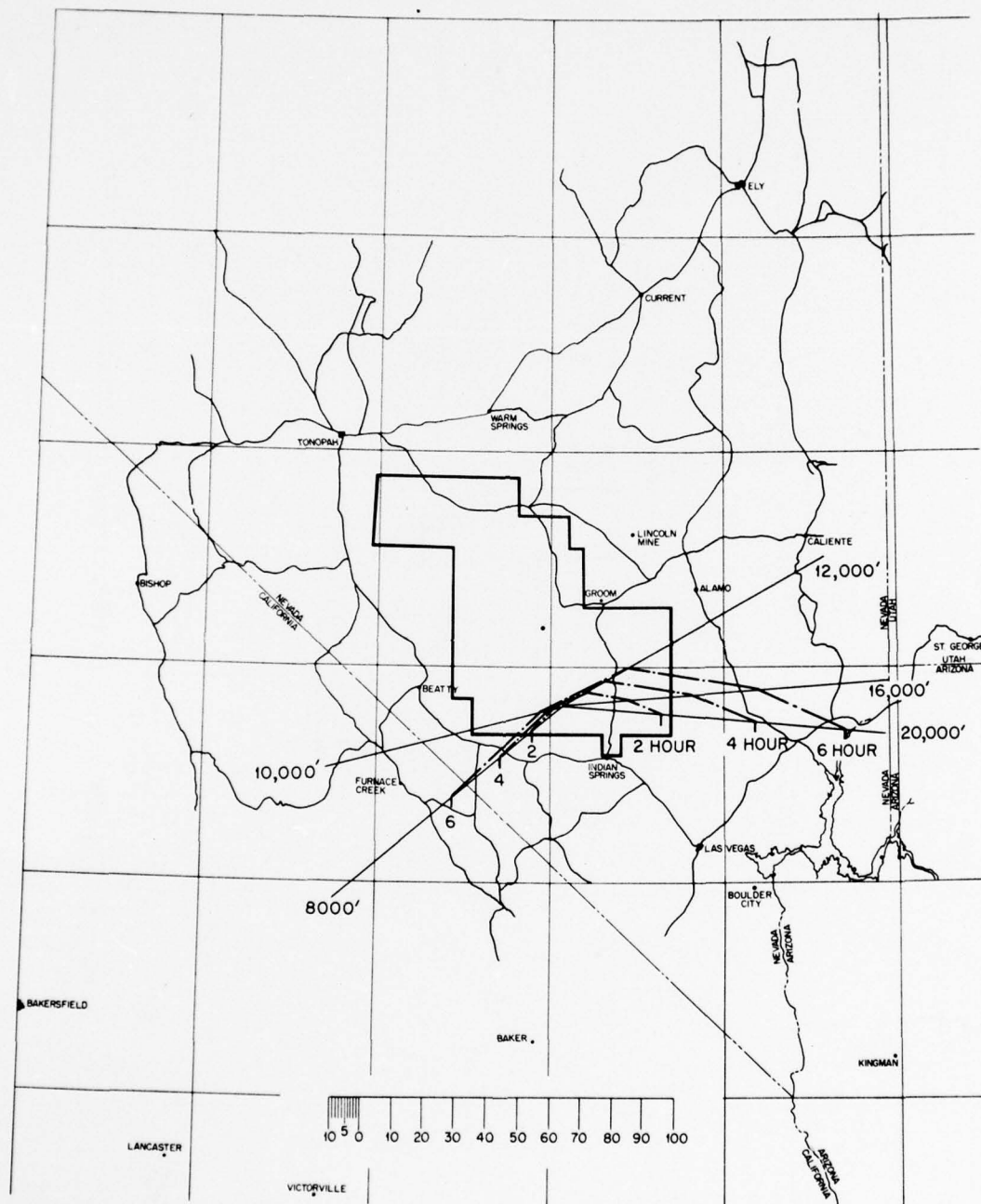


Fig. 2 — Fall-out plot for Tumbler-Snapper 1, prepared from wind sounding taken at 0600 PST D Day.

SECRET — SECURITY INFORMATION

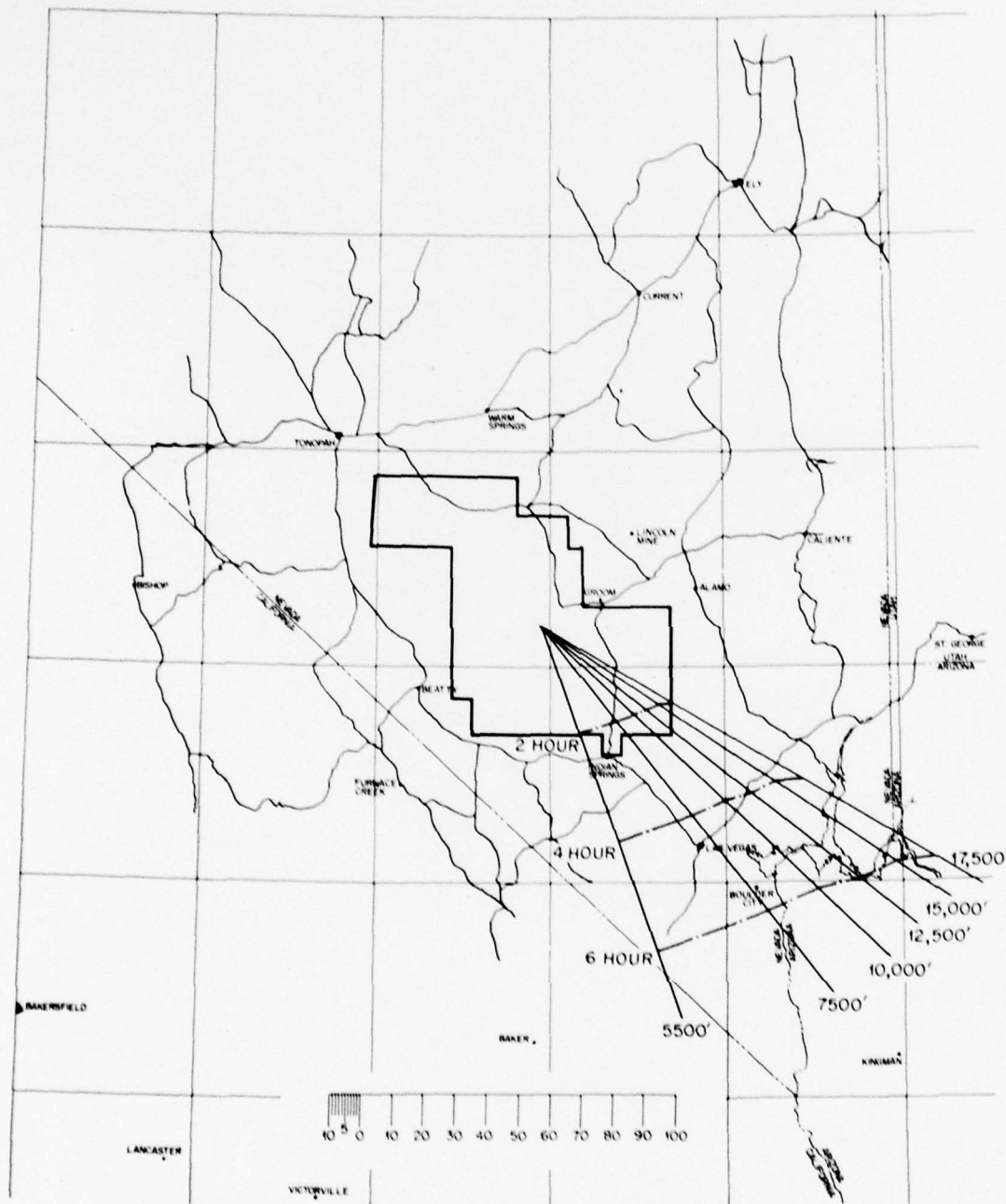


Fig. 3— Fall-out forecast for Tumbler-Snapper 2, prepared from briefing wind forecast at 2000 PST on D-1 day.

SECRET — SECURITY INFORMATION

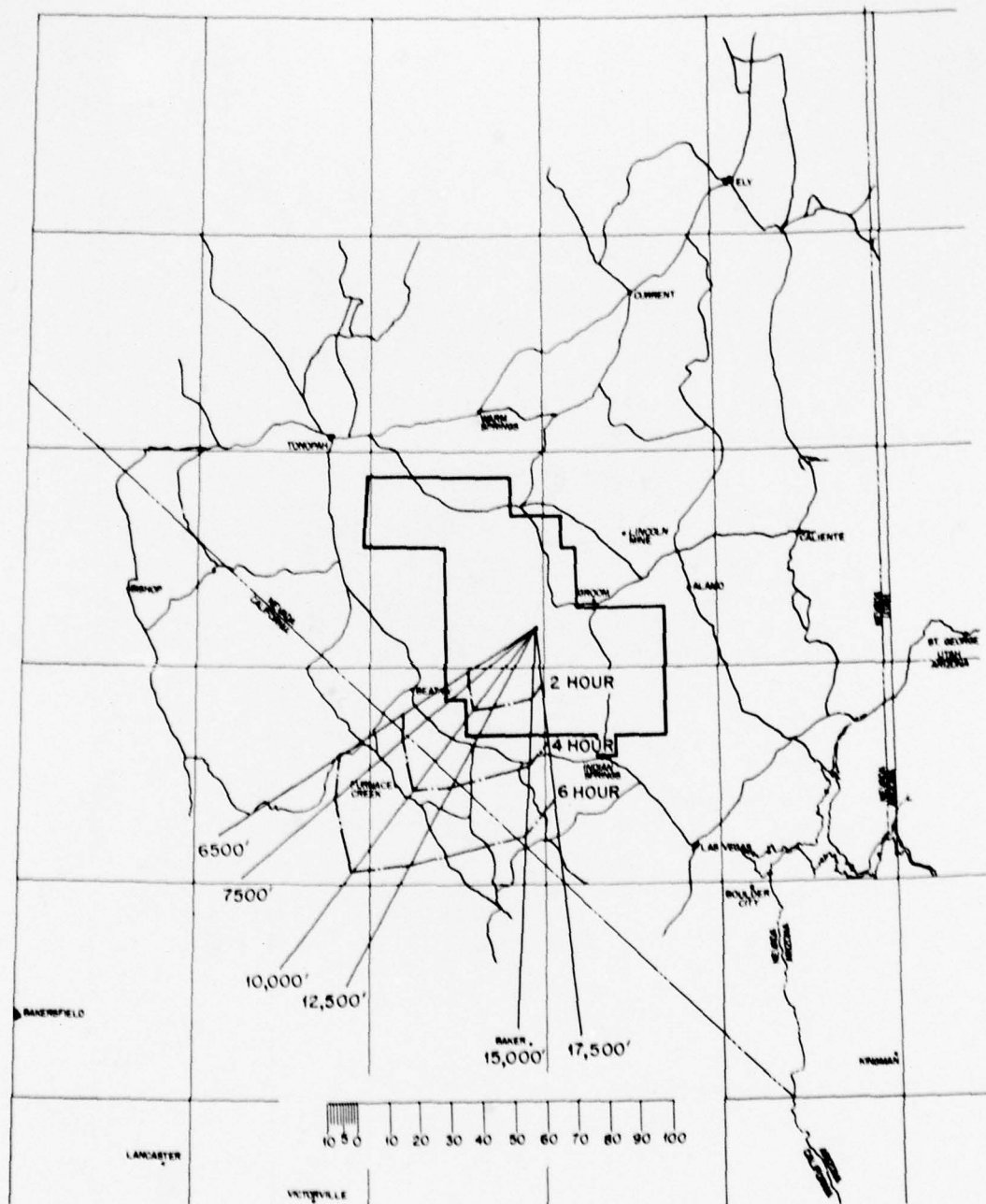


Fig. 4—Fall-out plot for Tumbler-Snapper 2, prepared from wind sounding taken at 0800 PST D Day.

SECRET — SECURITY INFORMATION

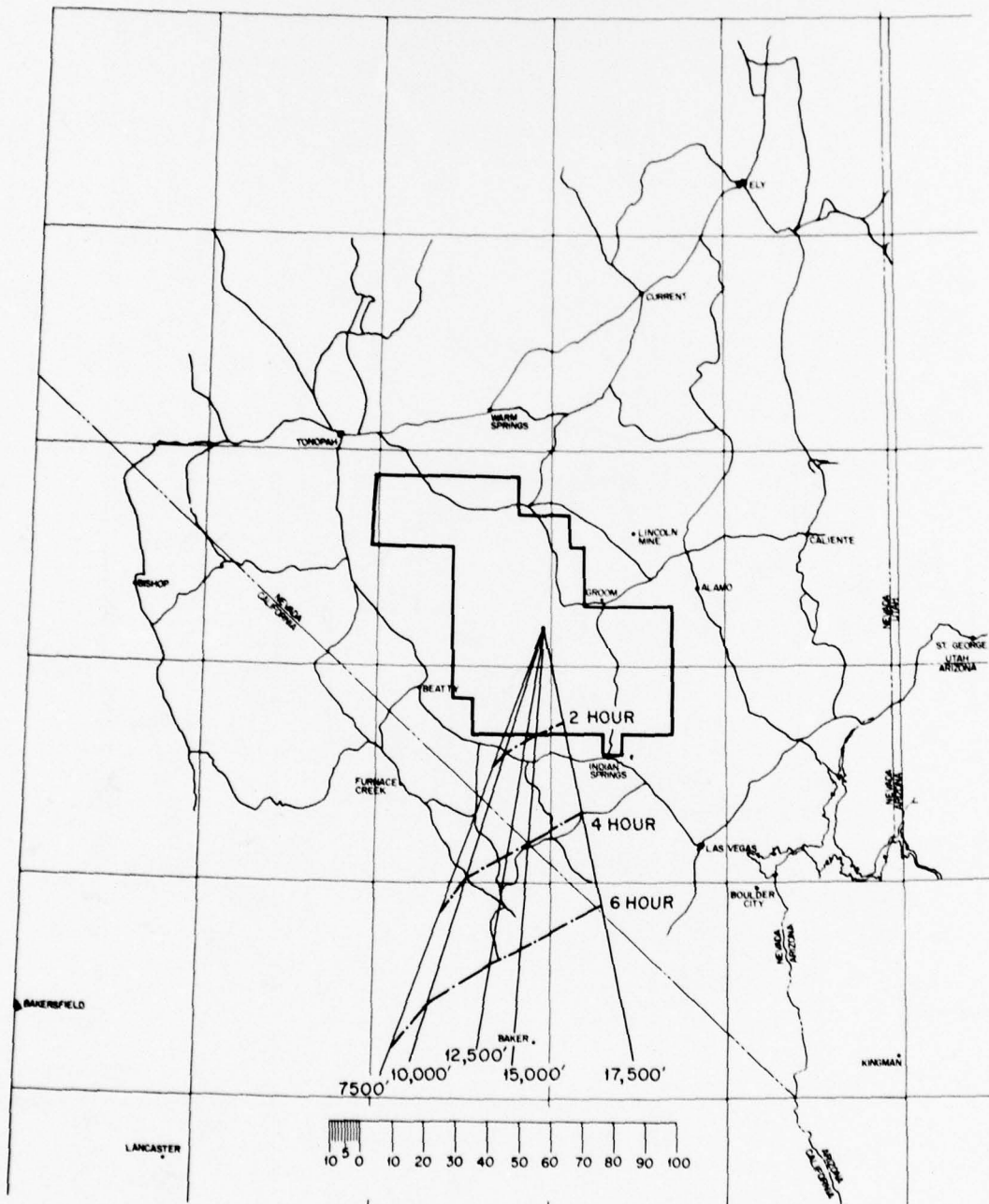


Fig. 5 — Fall-out plot for Tumbler-Snapper 2, prepared from wind sounding taken at 0800 PST D Day.

SECRET — SECURITY INFORMATION

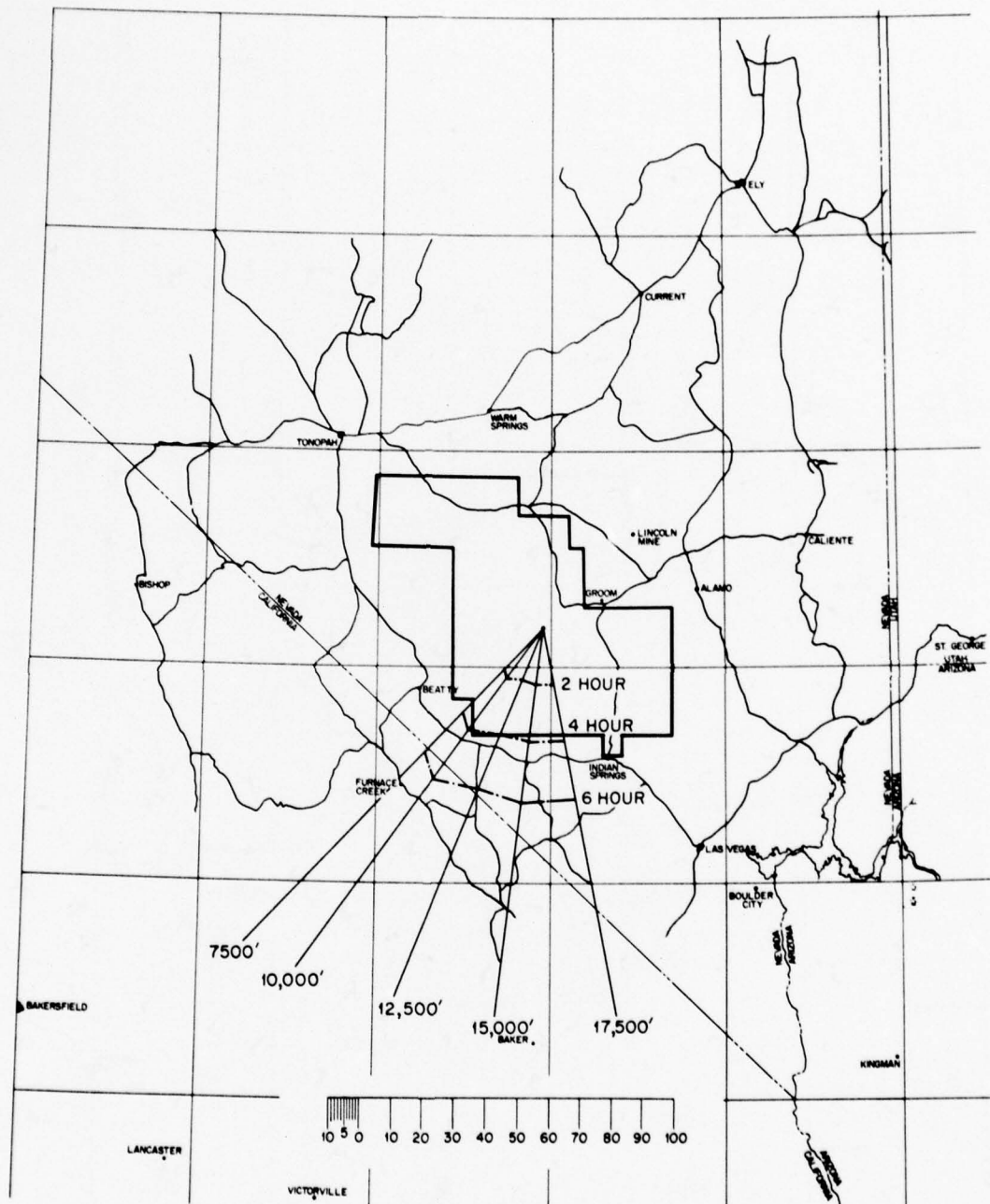


Fig. 6— Fall-out plot for Tumbler-Snapper 2, prepared from wind sounding taken at 1000 PST D Day.

SECRET — SECURITY INFORMATION

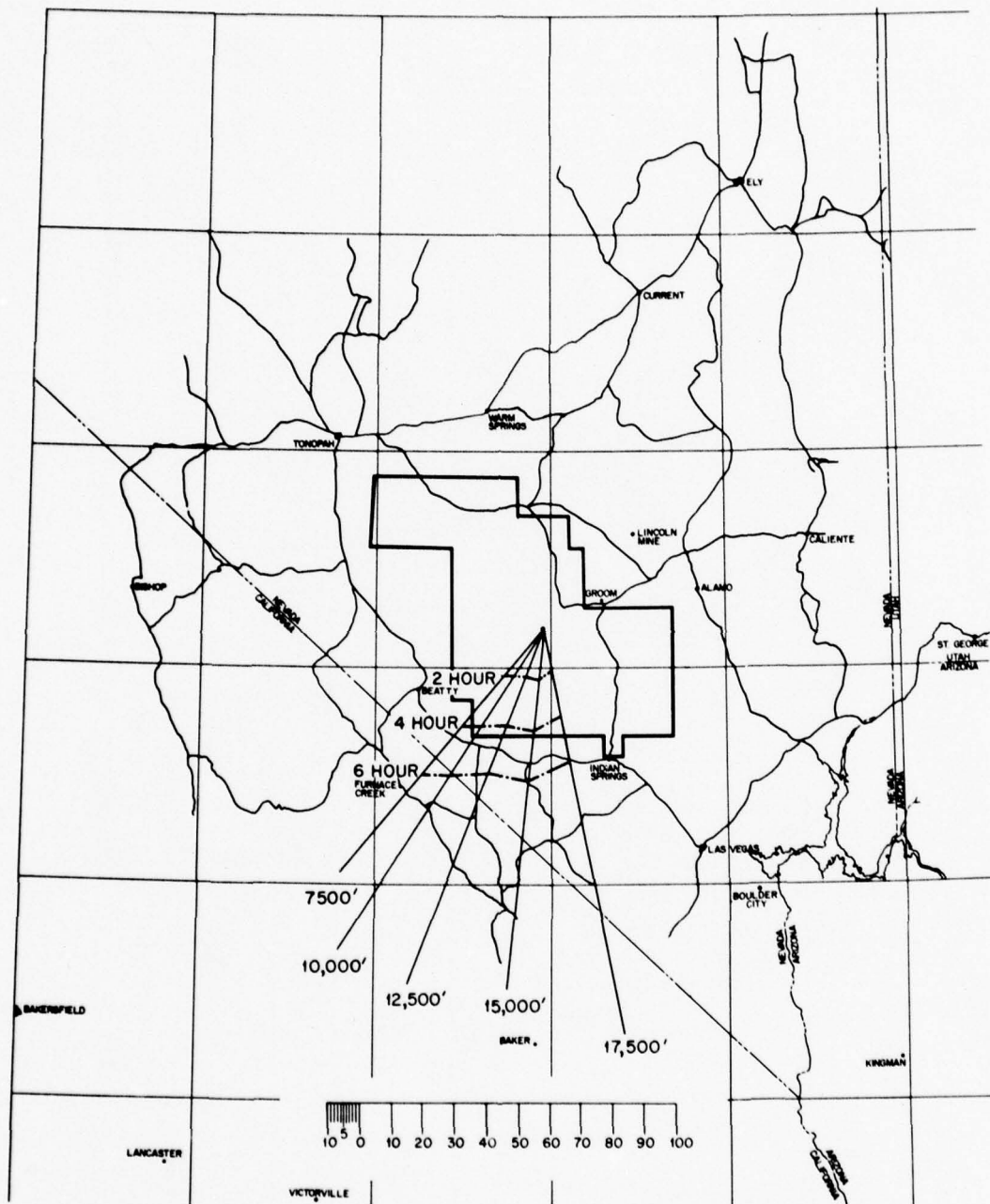


Fig. 7 — Fall-out plot for Tumbler-Snapper 2, prepared from wind sounding taken at 1300 PST D Day.

SECRET — SECURITY INFORMATION

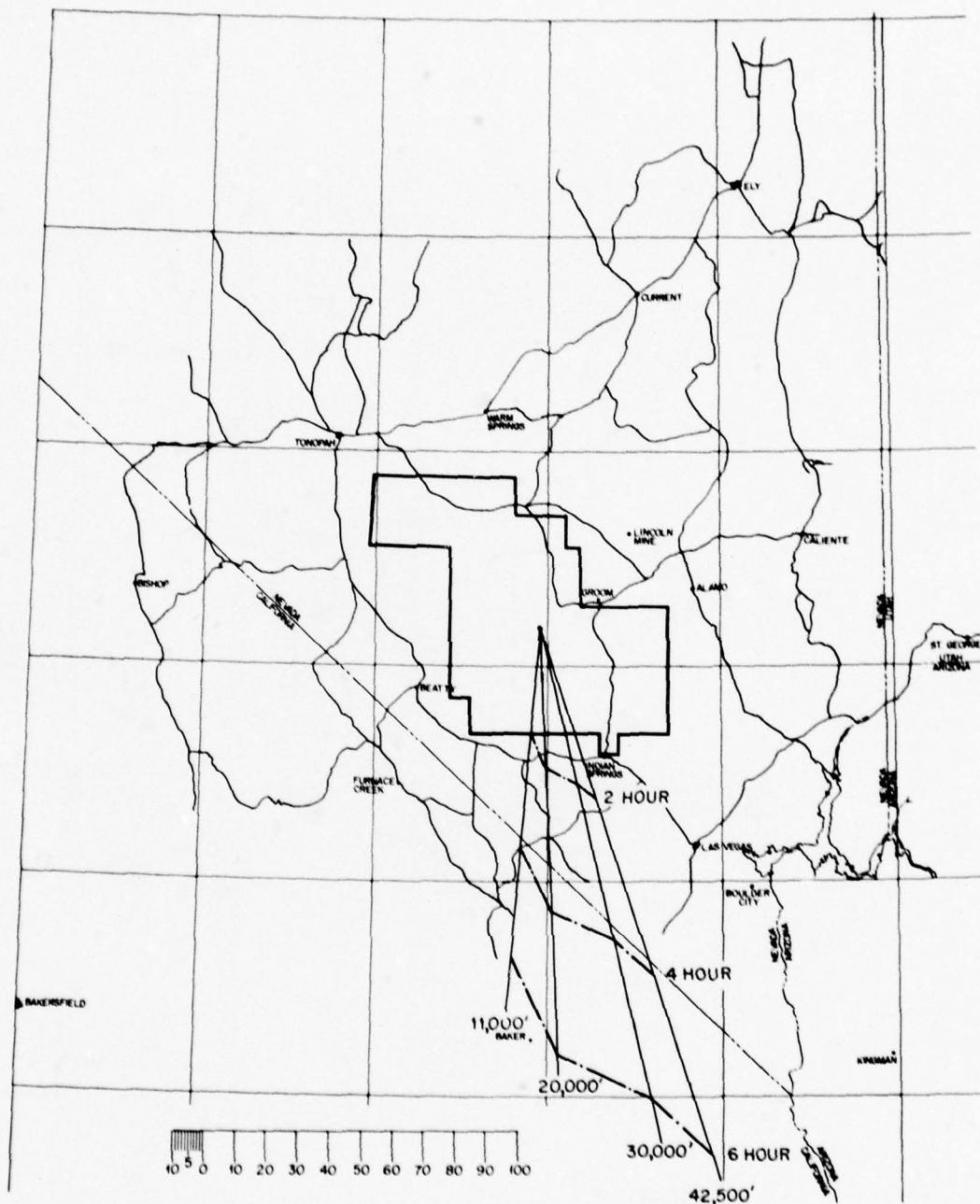
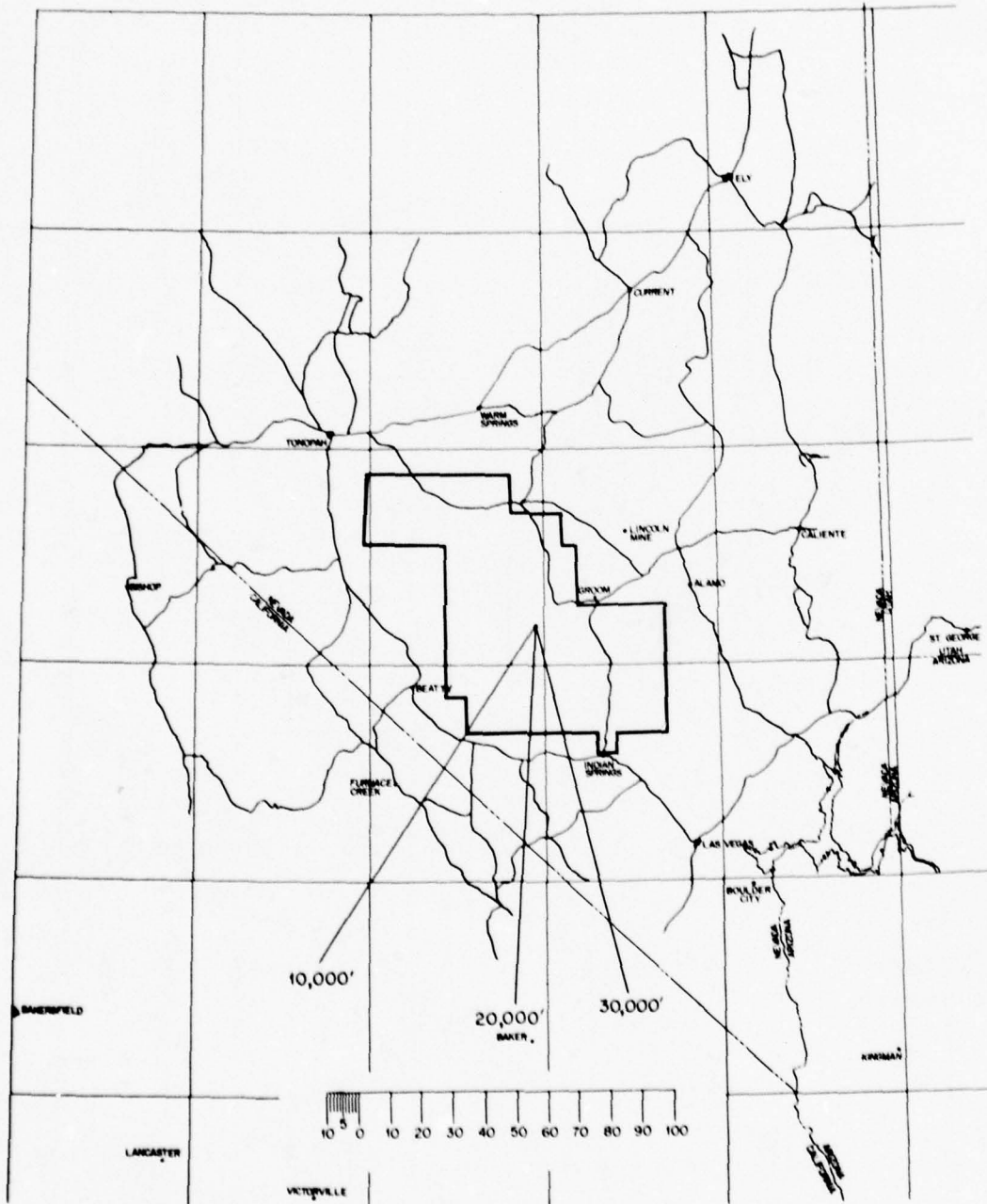


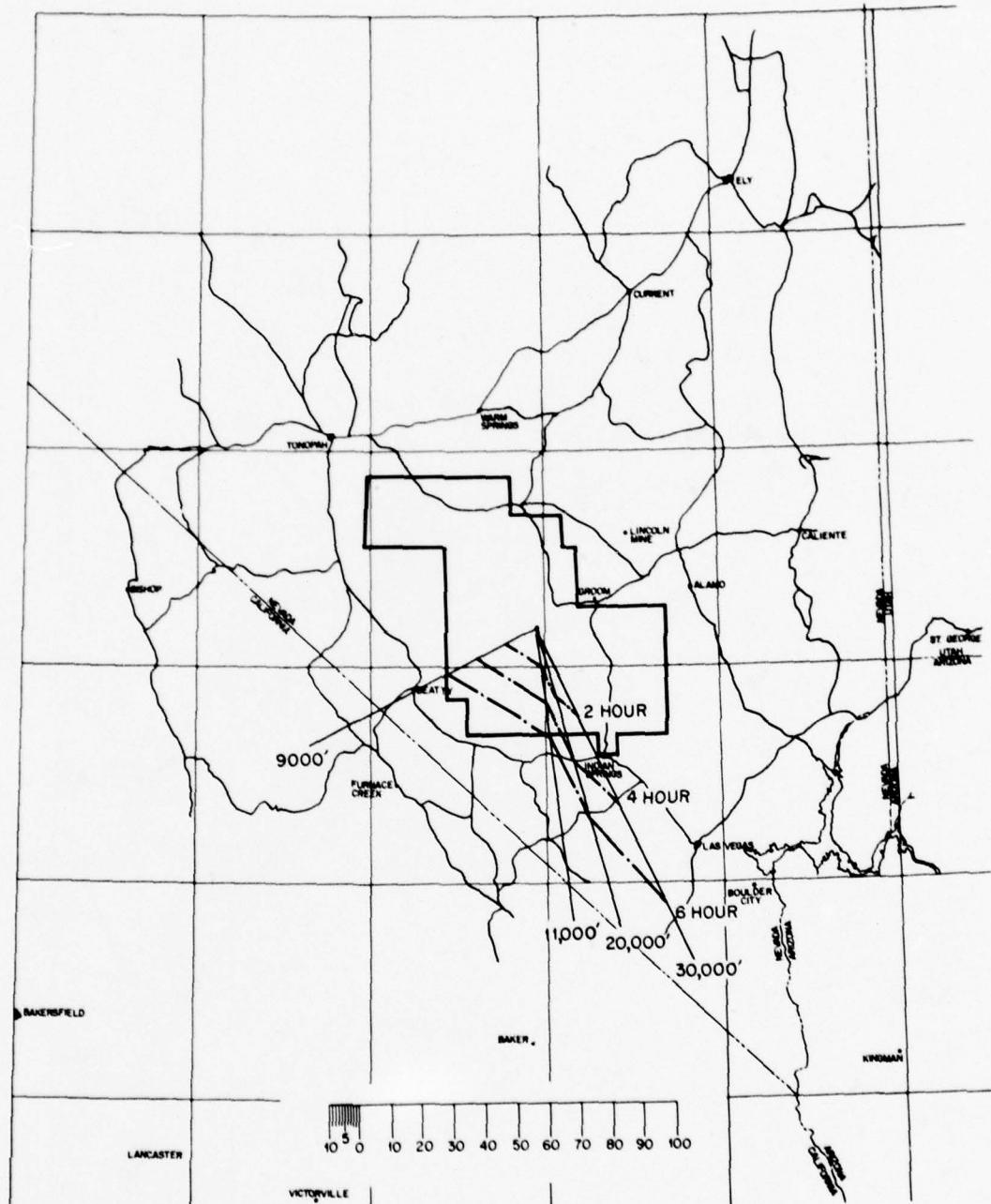
Fig. 8—Fall-out forecast for Tumbler-Snapper 3, prepared from briefing wind forecast at 2000 PST on D-1 day.

**SECRET — SECURITY INFORMATION**



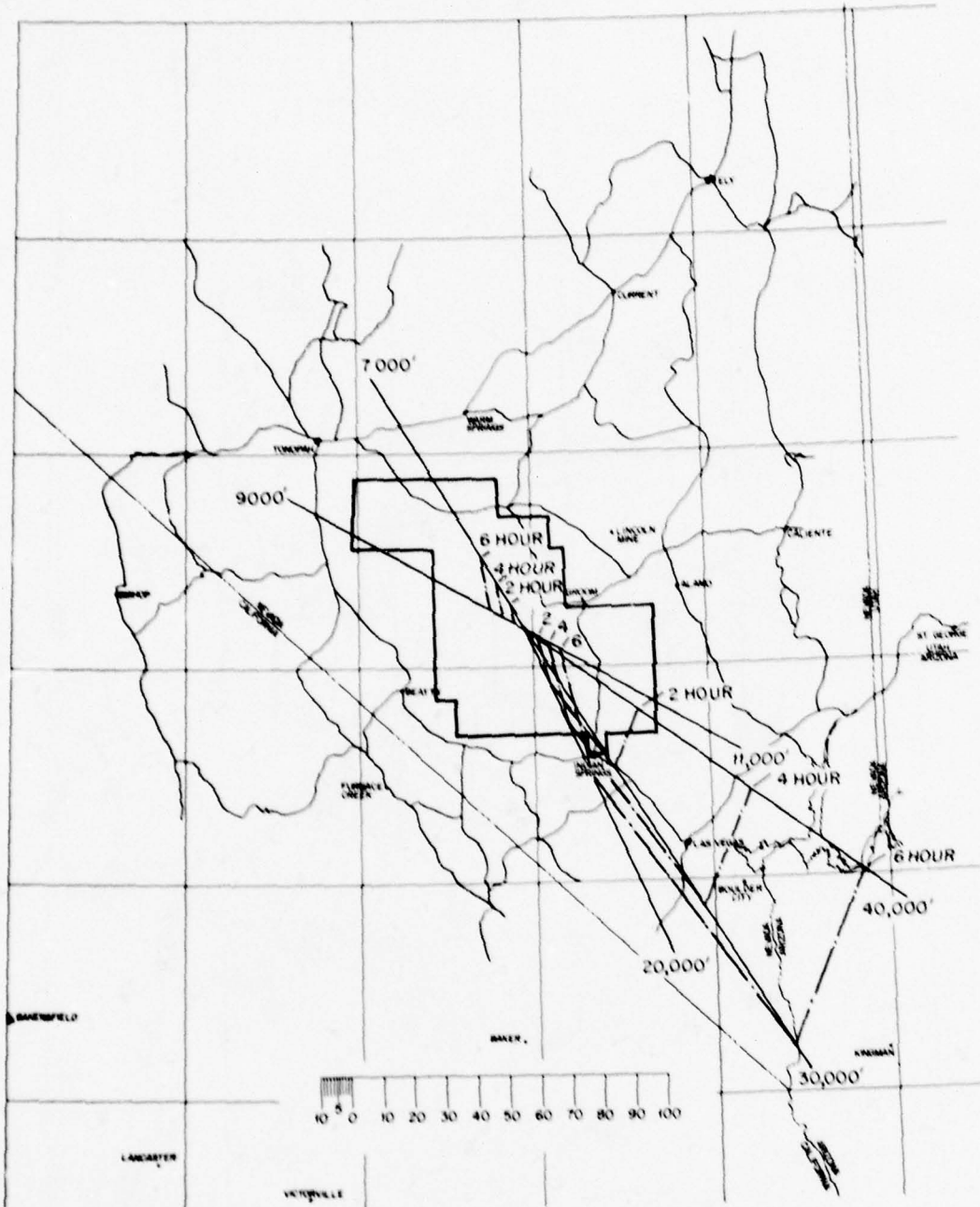
**Fig. 9—Fall-out plot for Tumbler-Snapper 3, prepared from wind sounding taken at 0600 PST D Day.**

**SECRET — SECURITY INFORMATION**



**Fig. 10—Fall-out plot for Tumbler-Snapper 3, prepared from wind sounding taken at 0800 PST D Day.**

**SECRET — SECURITY INFORMATION**



**Fig. 11—Fall-out plot for Tumbler-Snapper 3, prepared from wind sounding taken at 1000 PST D Day.**

SECRET — SECURITY INFORMATION

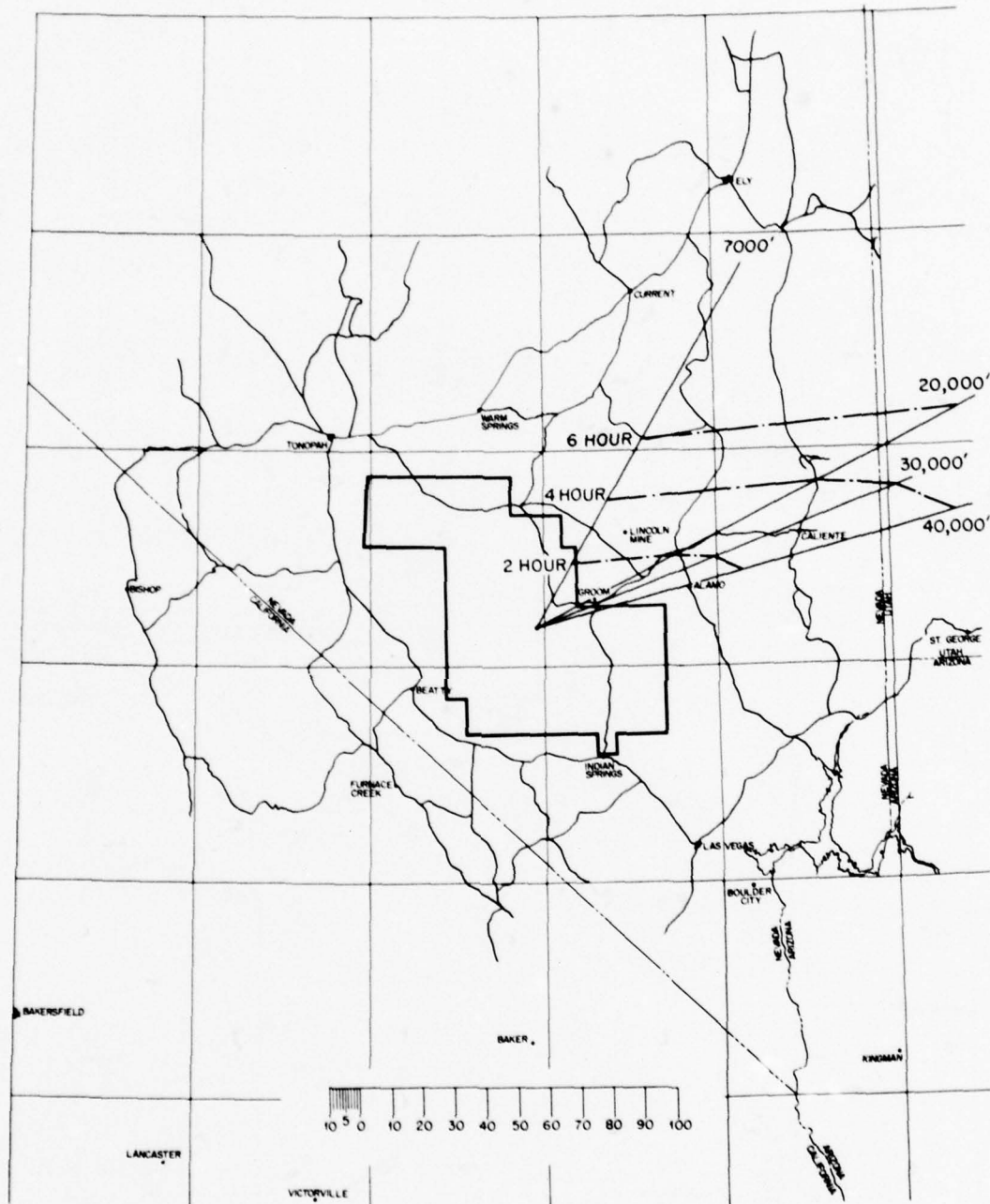


Fig. 12 — Fall-out forecast for Tumbler-Snapper 4, prepared from briefing wind forecast at 2000 PDT on D-1 day.

SECRET — SECURITY INFORMATION

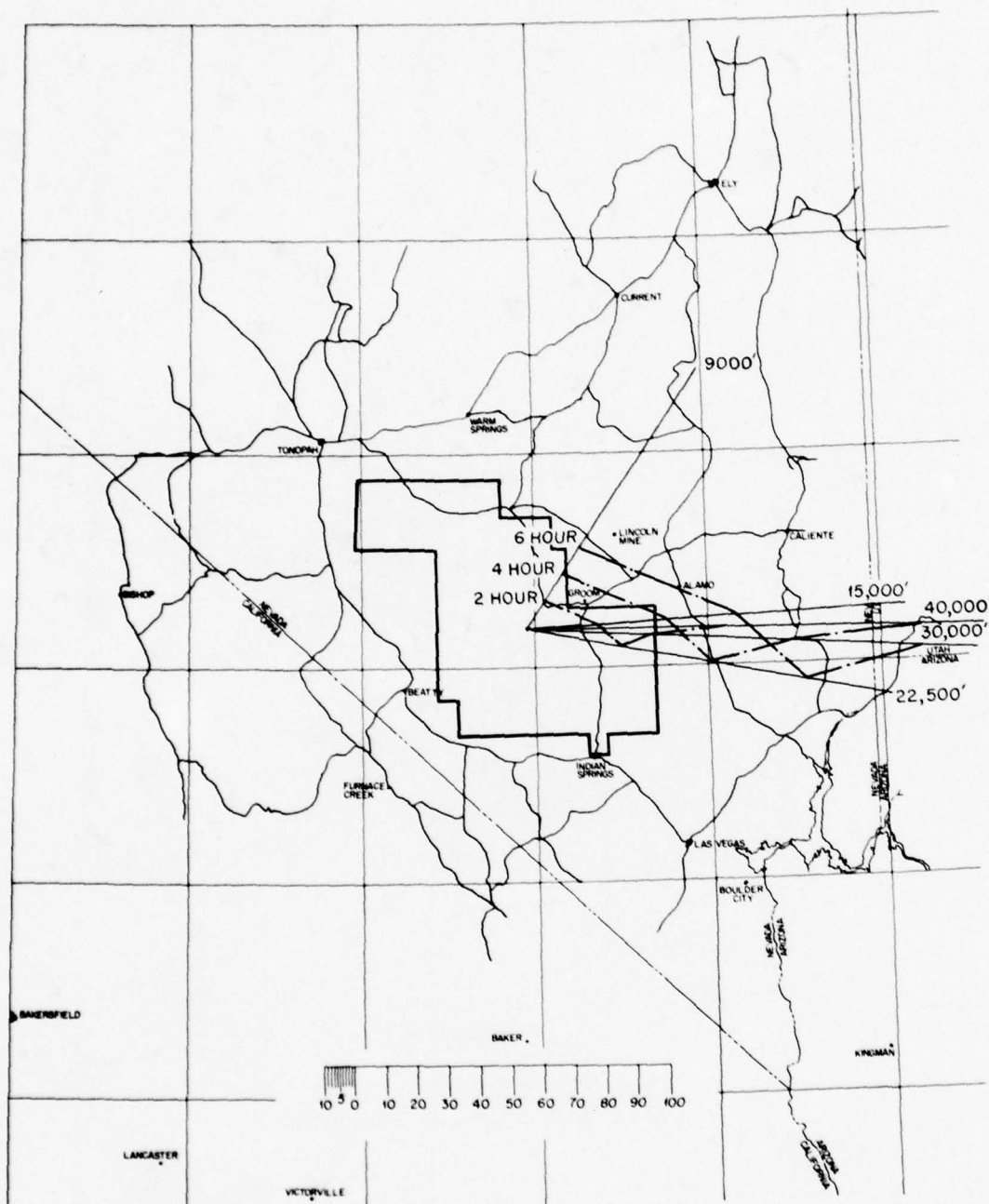


Fig. 13— Fall-out plot for Tumbler-Snapper 4, prepared from wind sounding taken at 0600 PDT D Day.

SECRET — SECURITY INFORMATION

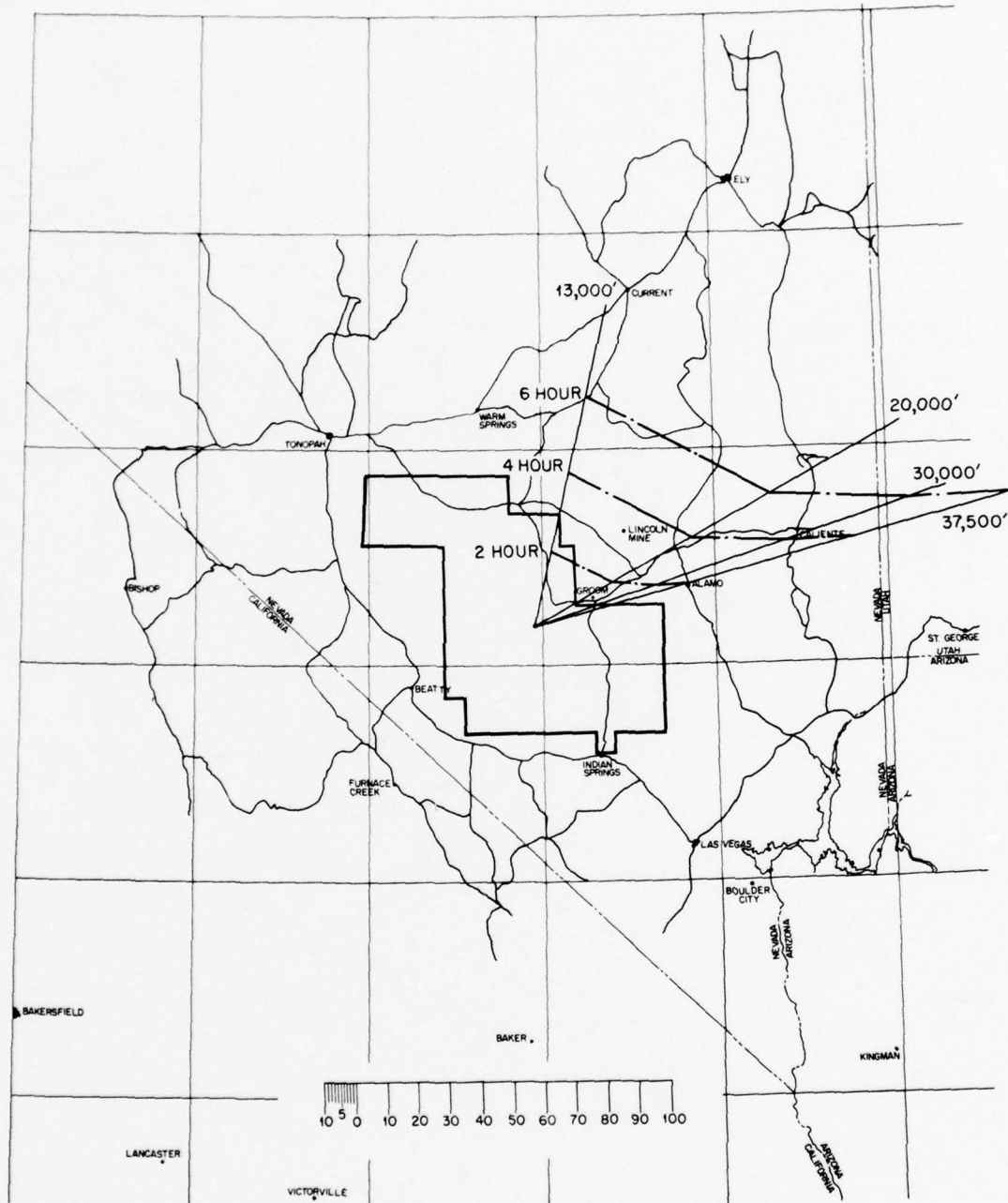


Fig. 14 — Fall-out plot for Tumbler-Snapper 4, prepared from wind sounding taken at 1000 PDT D Day.

SECRET — SECURITY INFORMATION

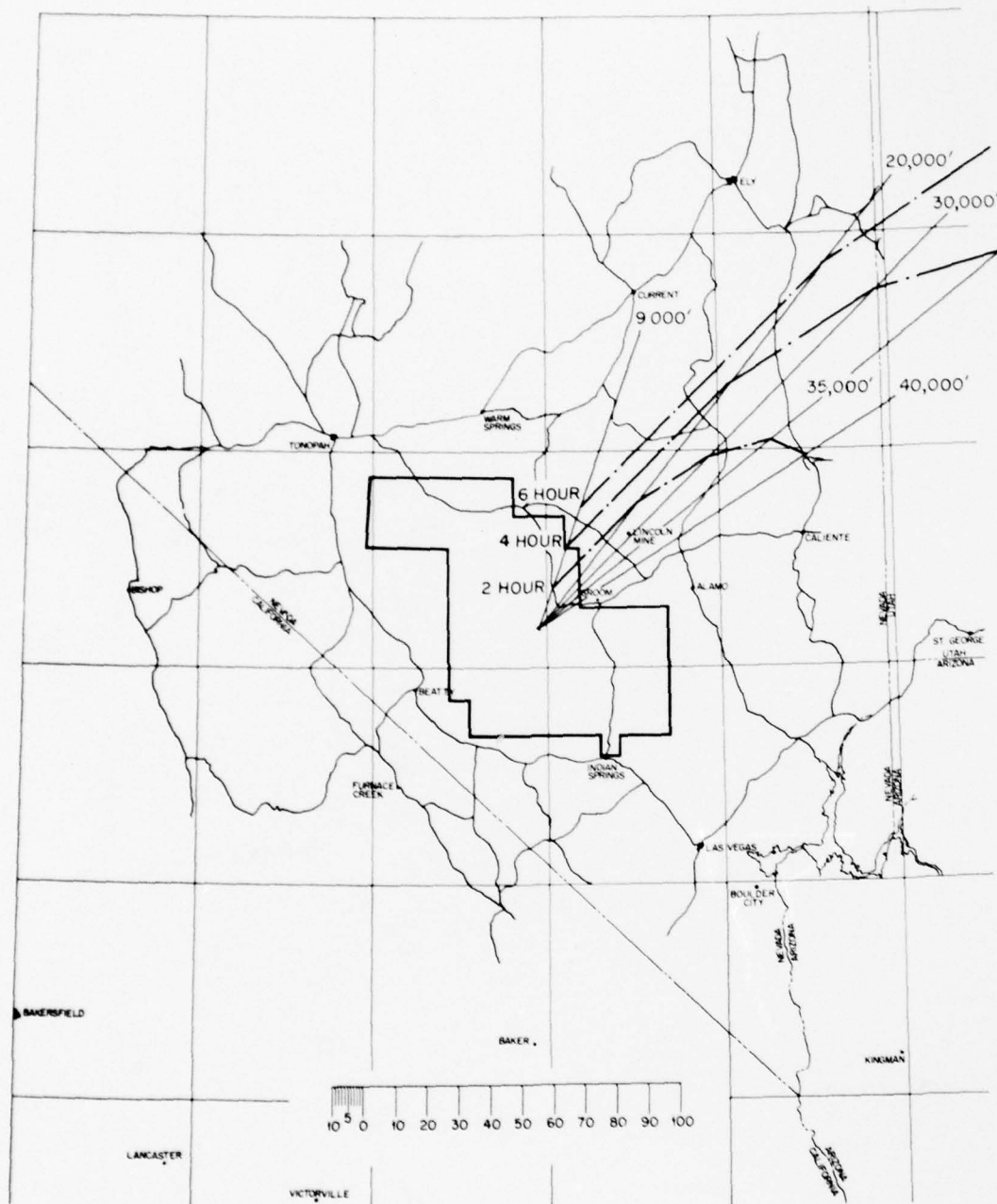


Fig. 15— Fall-out forecast for Tumbler-Snapper 5, prepared from briefing wind forecast at 2100 PDT on D-1 day.

SECRET — SECURITY INFORMATION

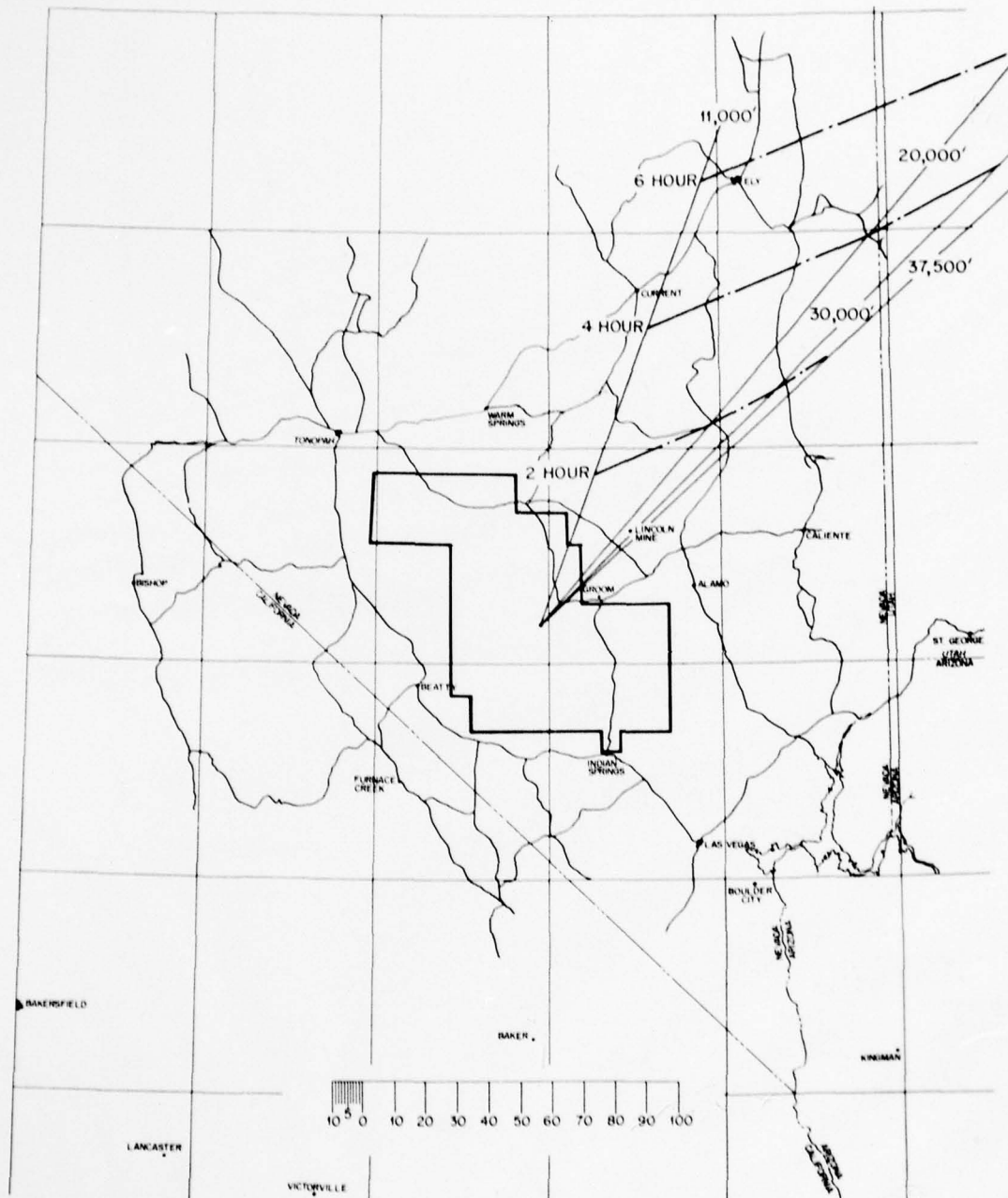


Fig. 16— Fall-out plot for Tumbler-Snapper 5, prepared from wind sounding taken at 0300 PDT D Day.

SECRET — SECURITY INFORMATION

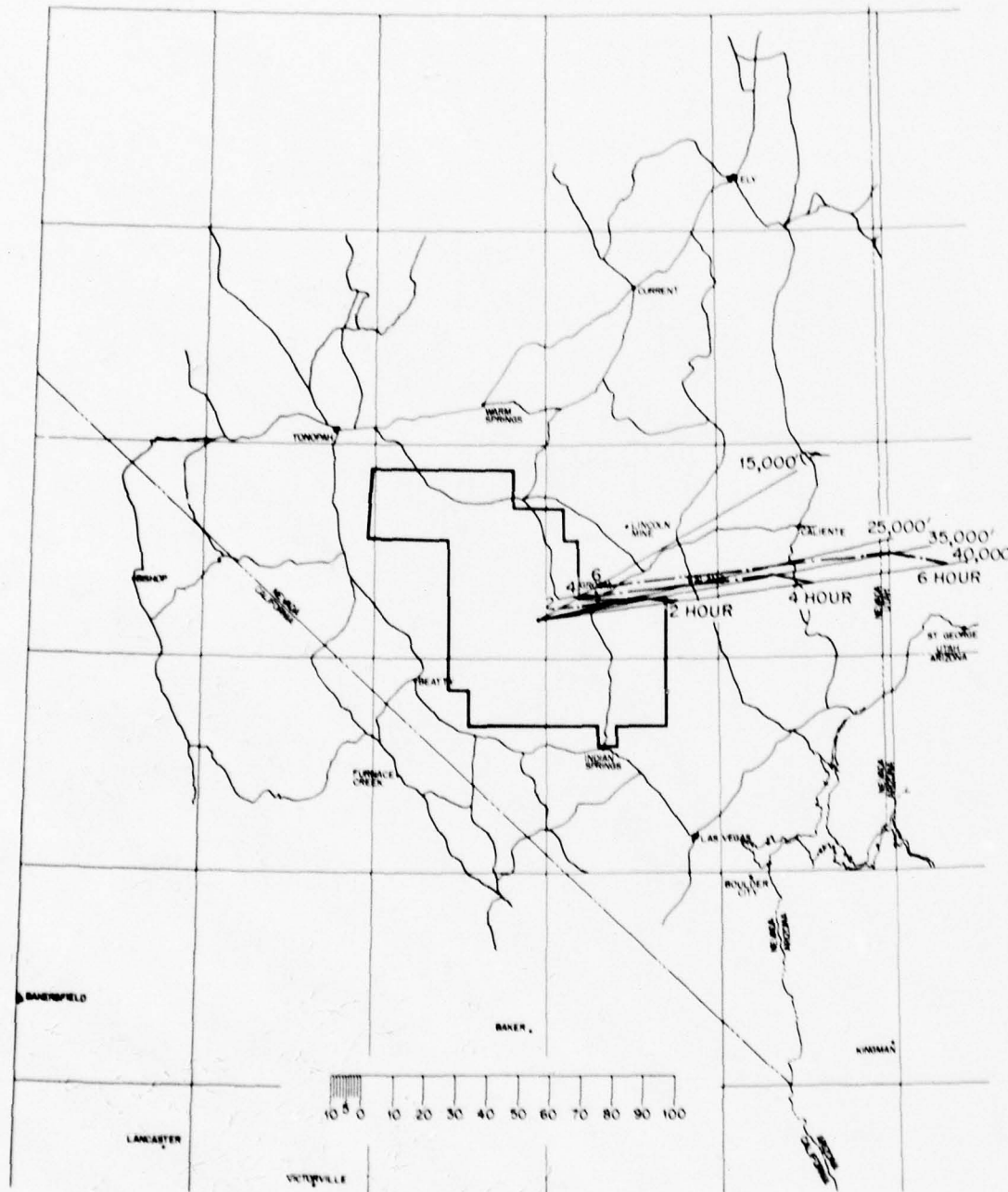


Fig. 17—Preliminary fall-out forecast for Tumbler-Snapper 6, prepared from 48-hr wind forecast on D-2 day.

SECRET — SECURITY INFORMATION

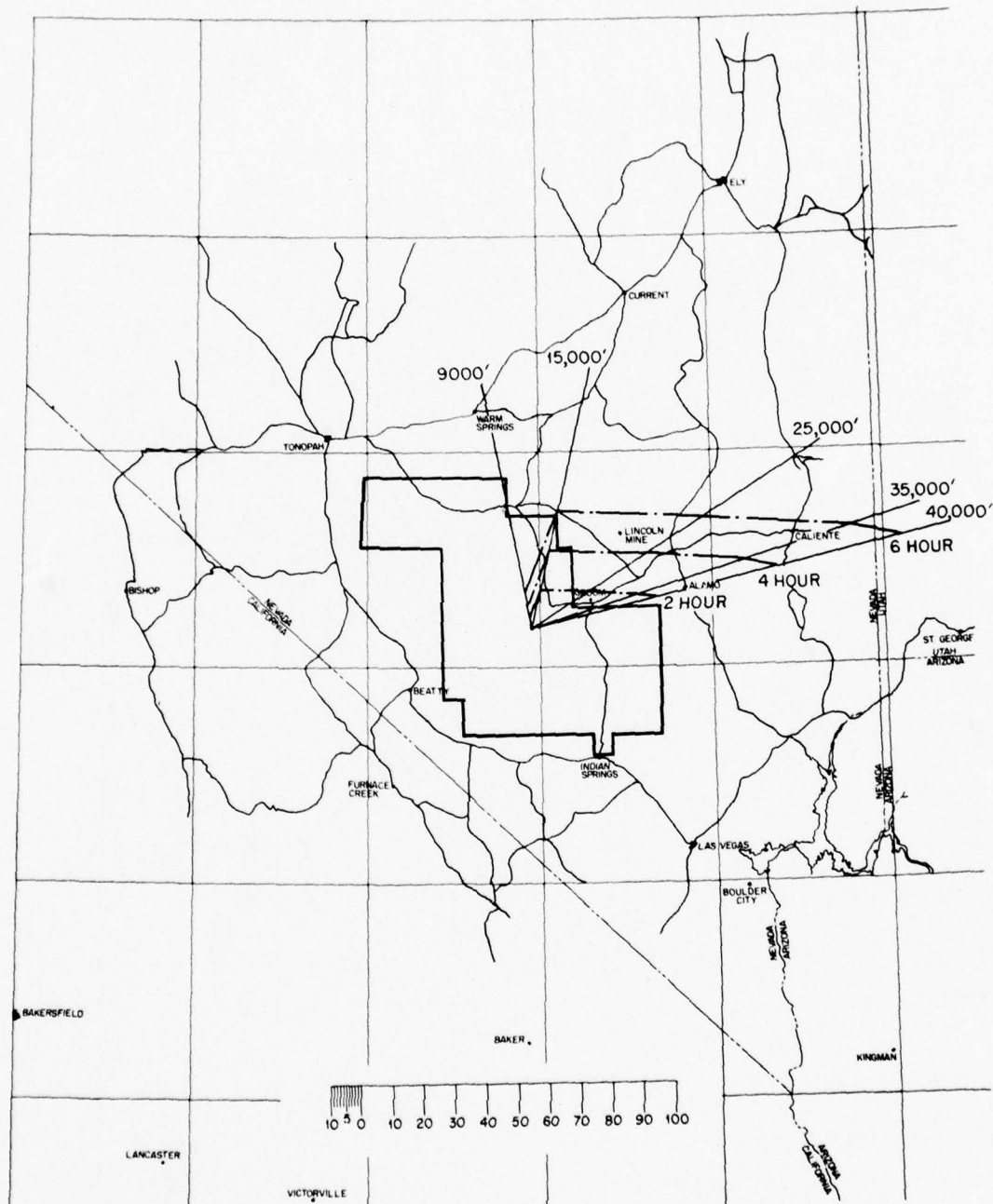


Fig. 18 — Fall-out forecast for Tumbler-Snapper 6, prepared from briefing wind forecast at 2100 PDT on D-1 day.

SECRET — SECURITY INFORMATION

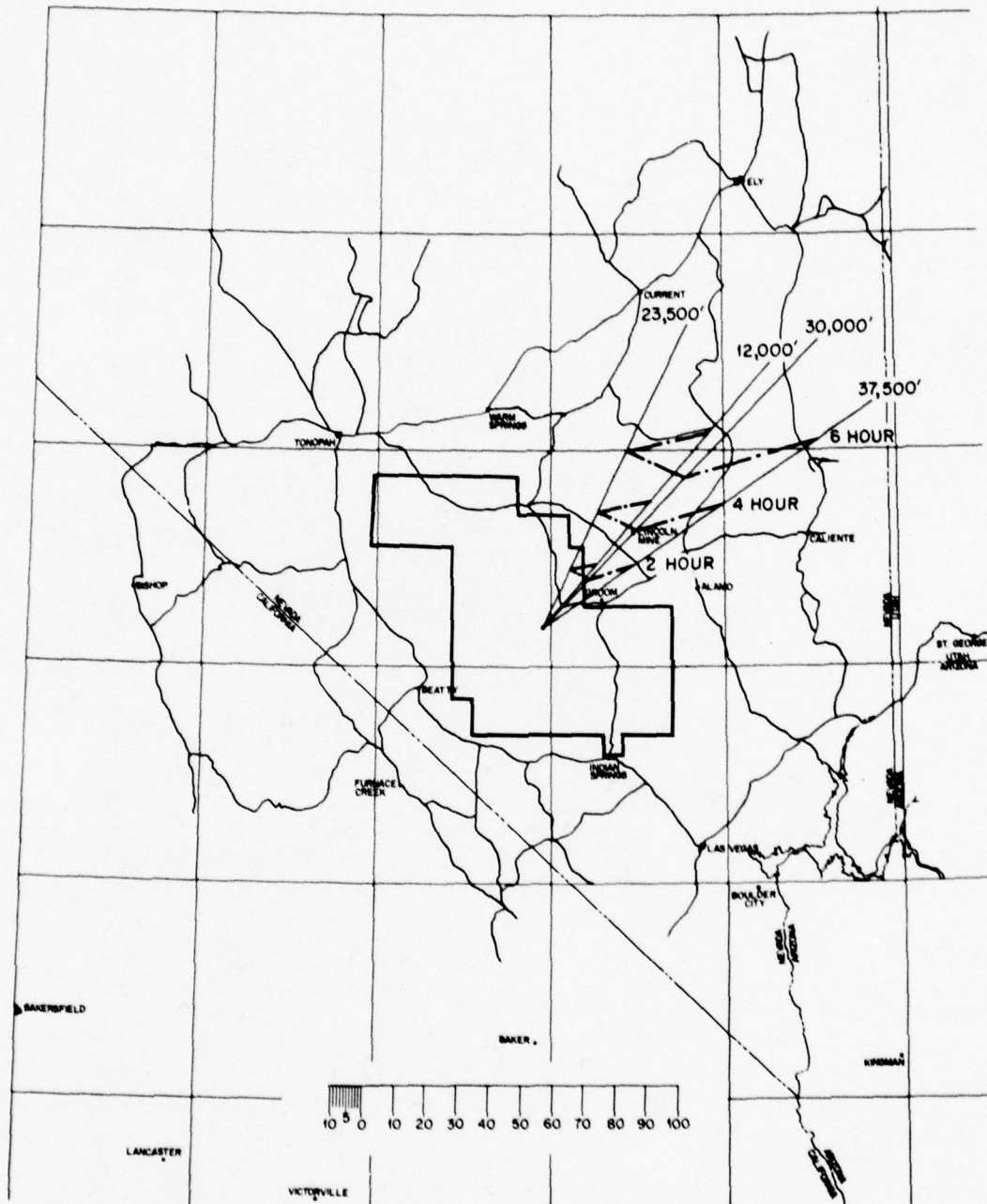


Fig. 19—Fall-out plot for Tumbler-Snapper 6, prepared from wind sounding taken at 0200 PDT D Day.

SECRET — SECURITY INFORMATION

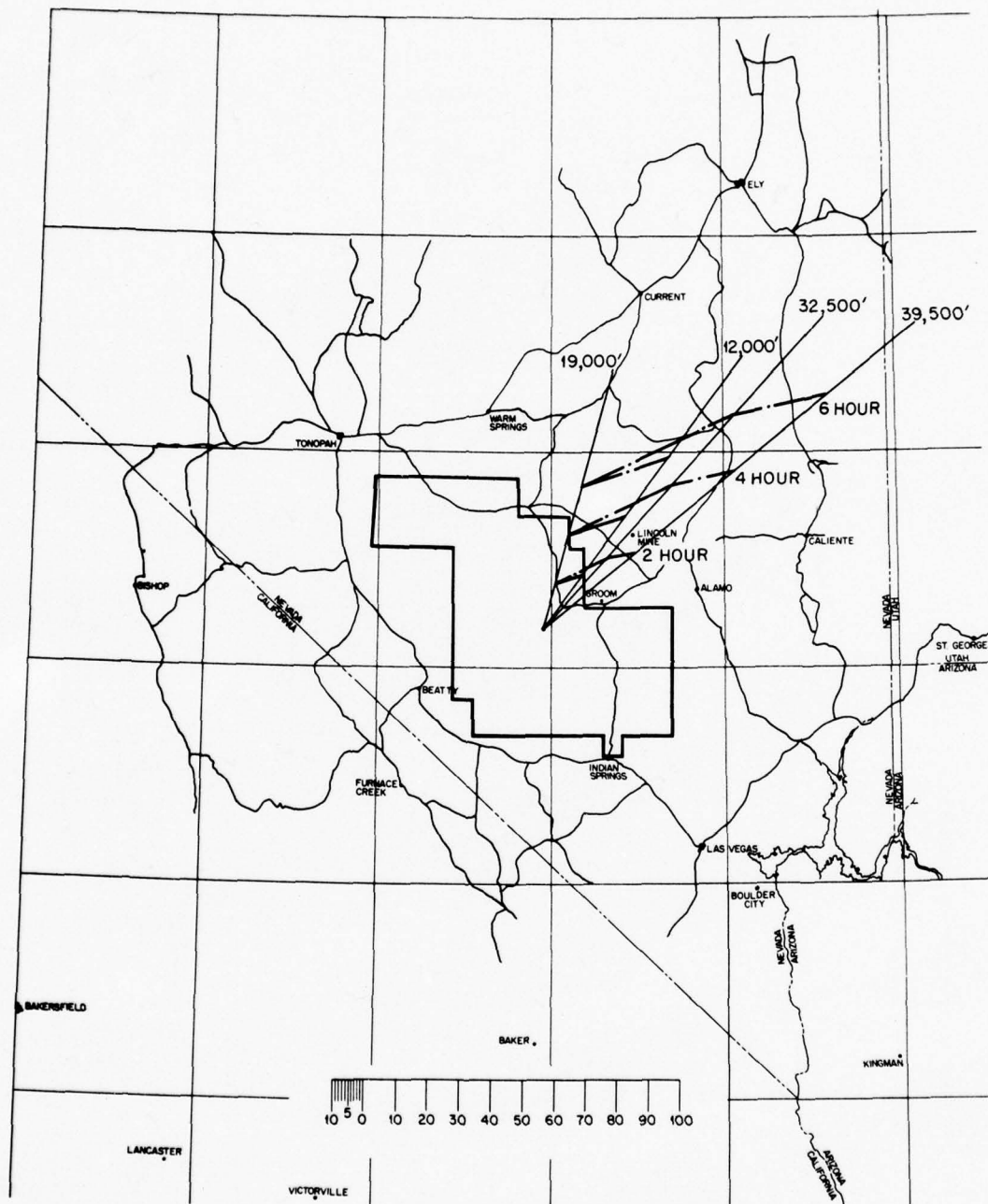


Fig. 20—Fall-out plot for Tumbler-Snapper 6, prepared from wind sounding taken at 0400 PDT D Day.

SECRET — SECURITY INFORMATION

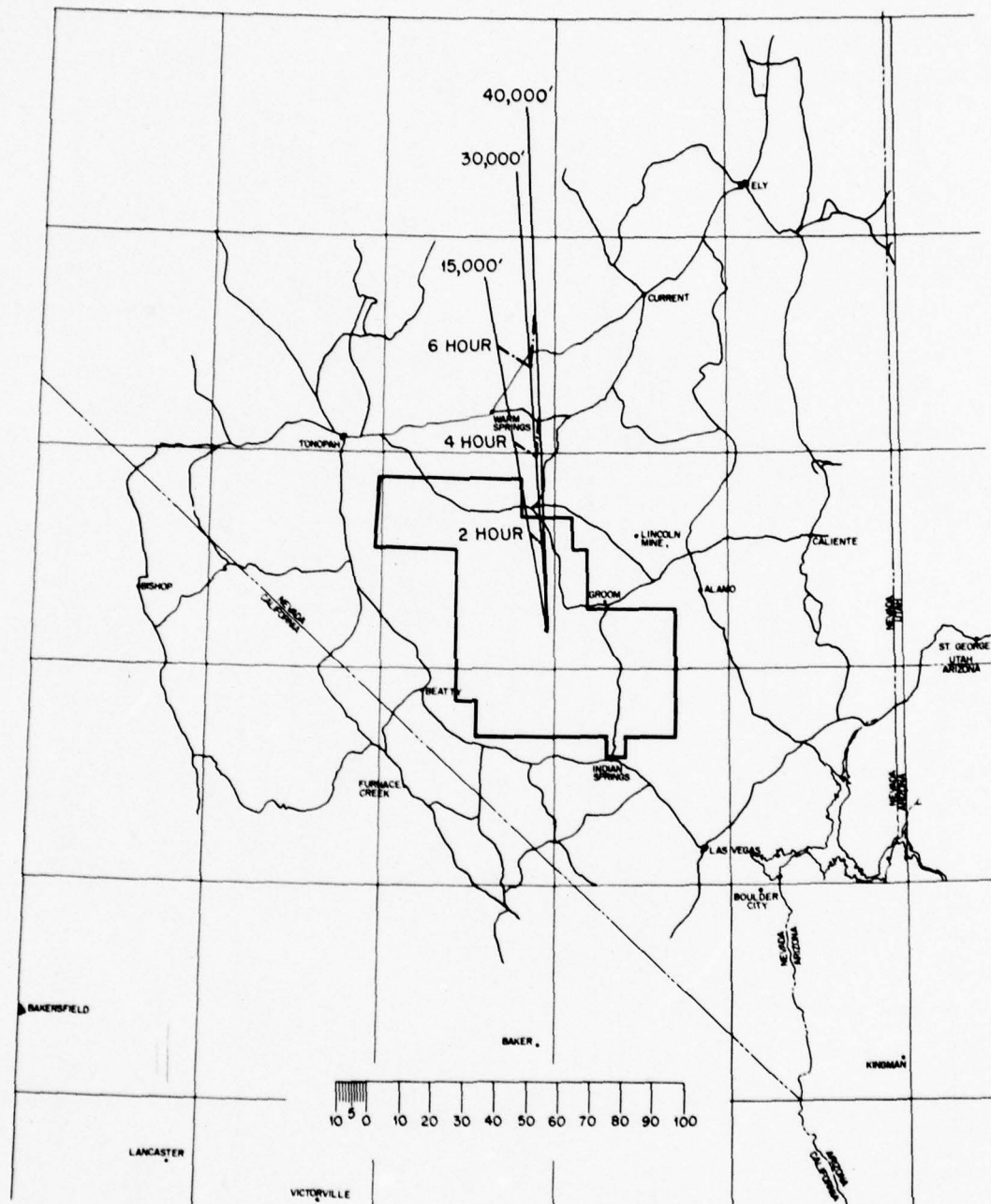
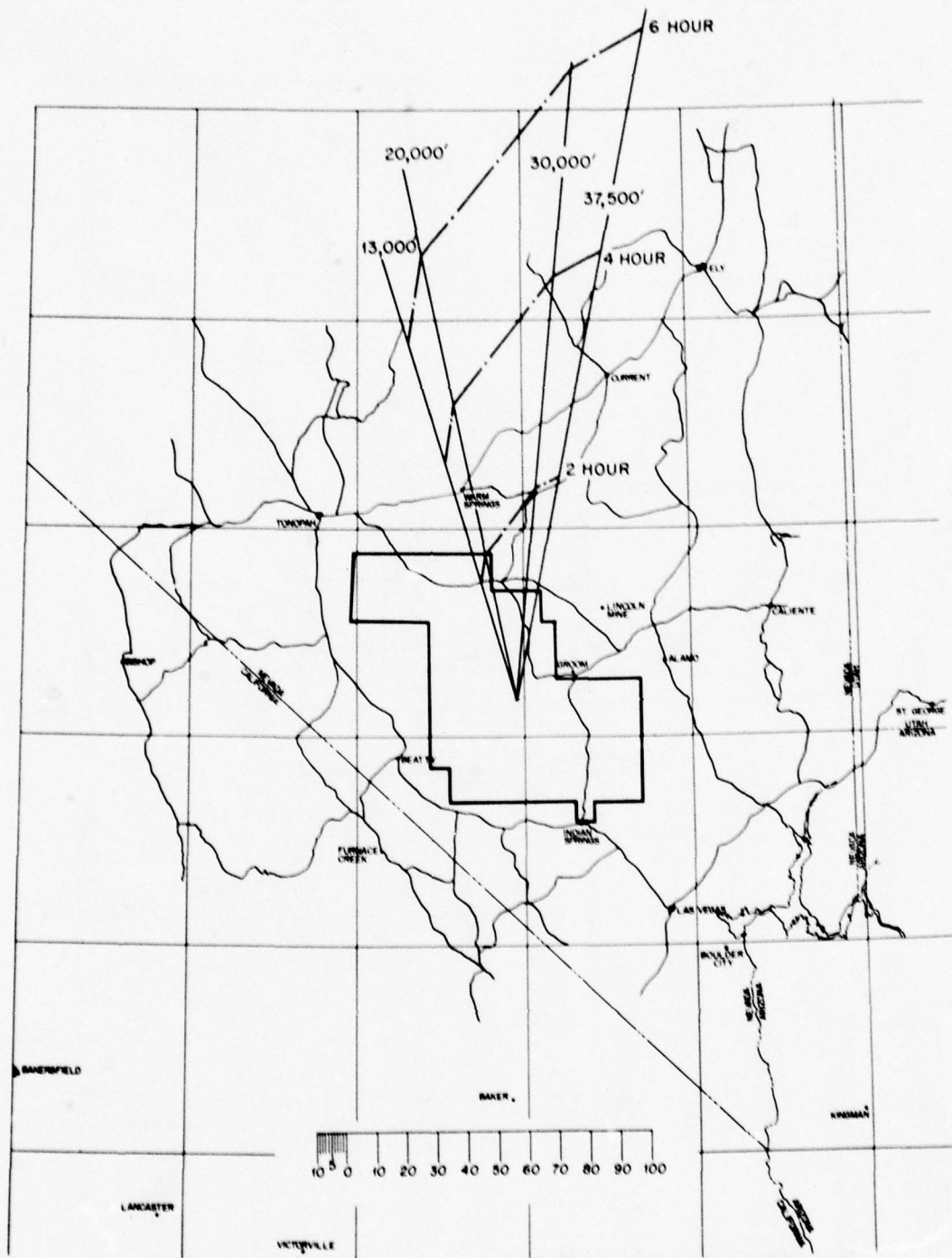


Fig. 21 — Fall-out forecast for Tumbler-Snapper 7, prepared from briefing wind forecast at 2100 PDT on D-1 day.

**SECRET - SECURITY INFORMATION**



**Fig. 22—**Fall-out plot for Tumbler-Snapper 7, prepared from wind sounding taken at 0300 PDT D Day.

SECRET — SECURITY INFORMATION

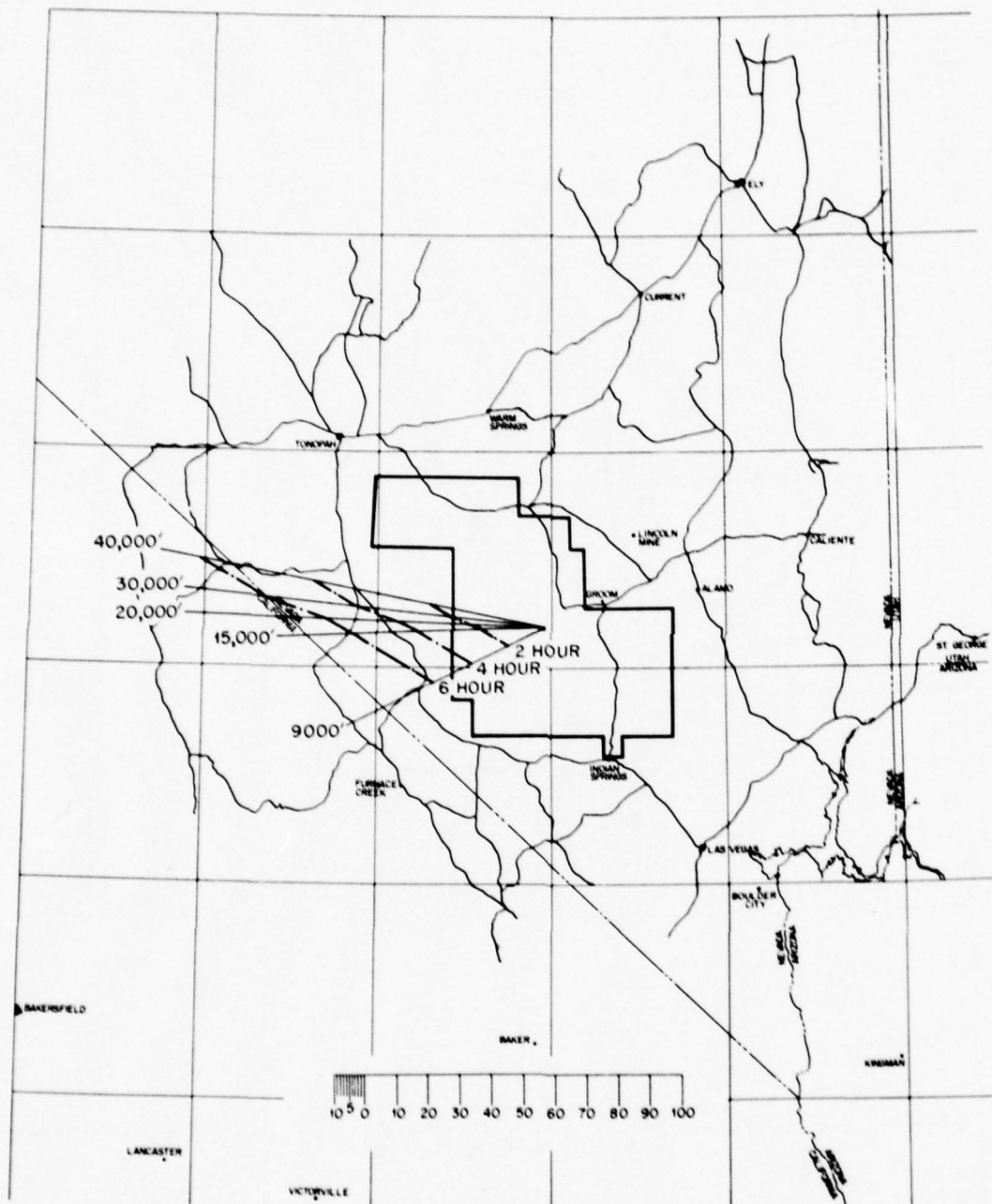


Fig. 23— Fall-out forecast for Tumbler-Snapper 8, prepared from briefing wind forecast at 2100 PDT on D-1 day.

SECRET — SECURITY INFORMATION

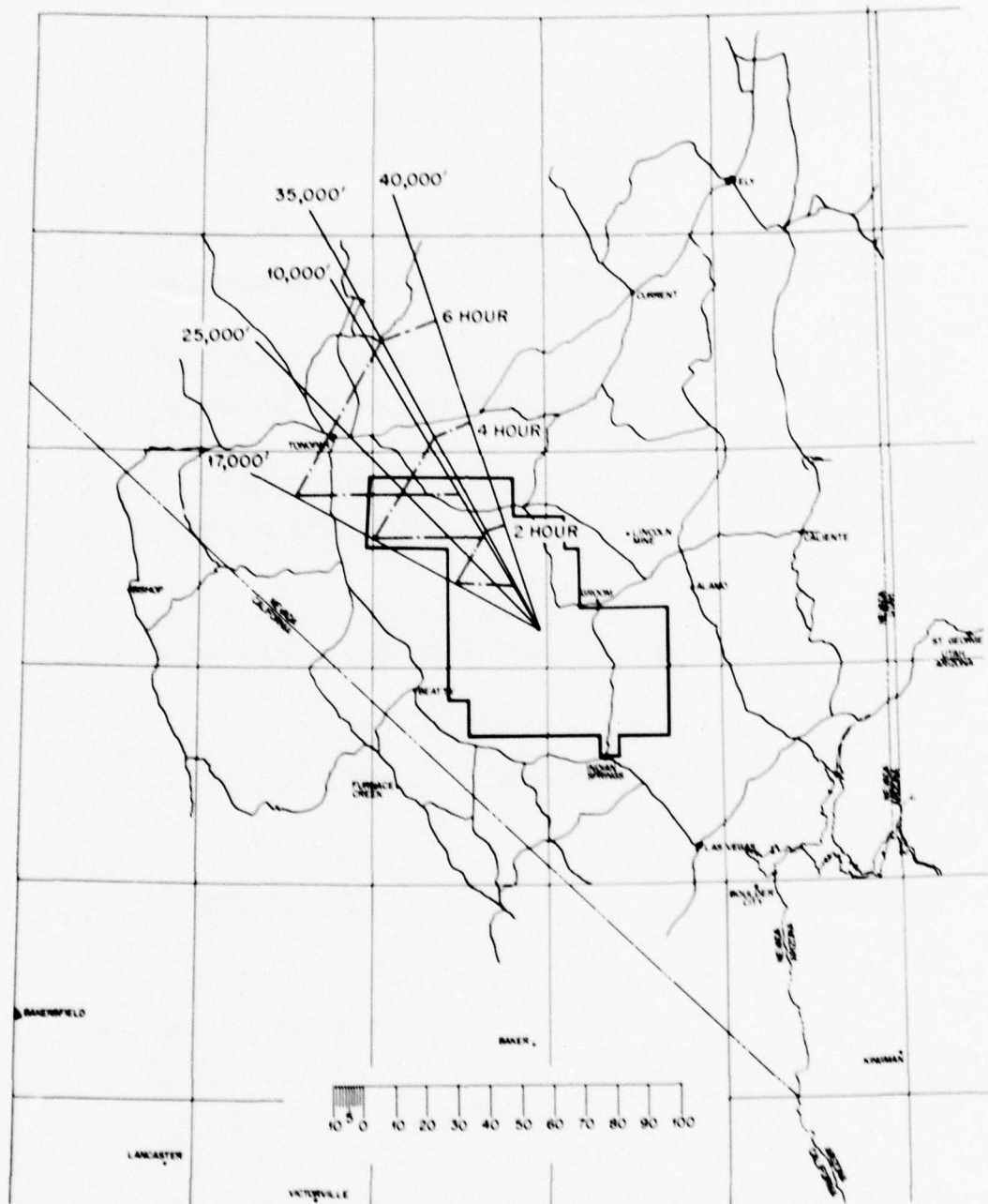


Fig. 24 — Fall-out plot for Tumbler-Snapper 8, prepared from wind sounding taken at 0300 PDT D Day.

SECRET — SECURITY INFORMATION



Fig. 25—Forecast and computed cloud heights for the Tumbler-Snapper test series (computed values based on CP theodolite data).

SECRET — SECURITY INFORMATION

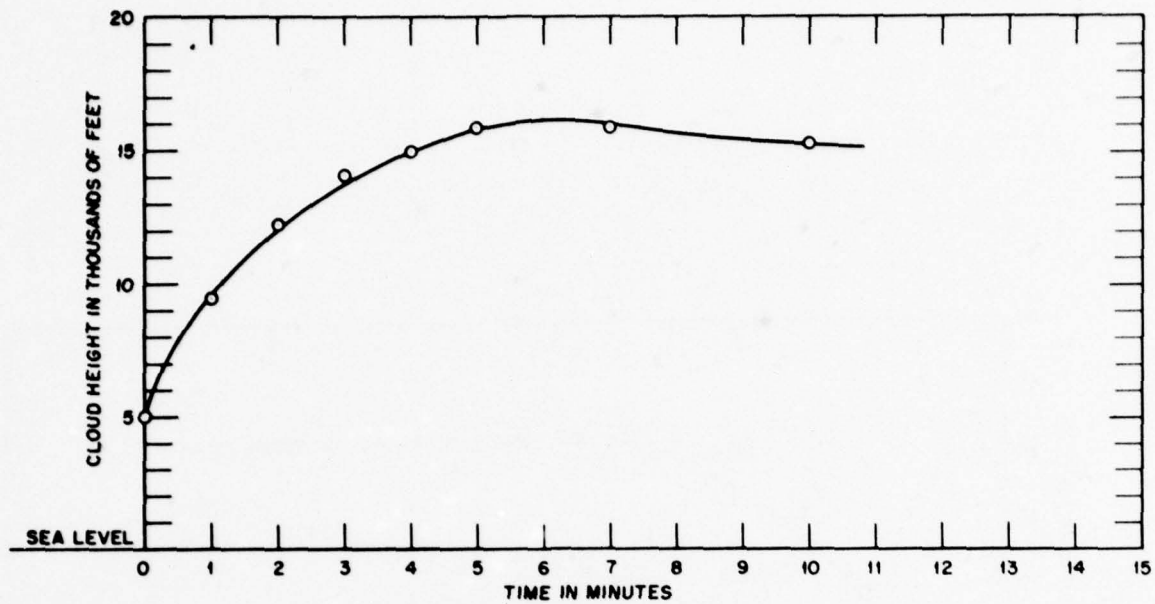


Fig. 26—Cloud height rate-of-growth curve for Tumbler-Snapper 1.

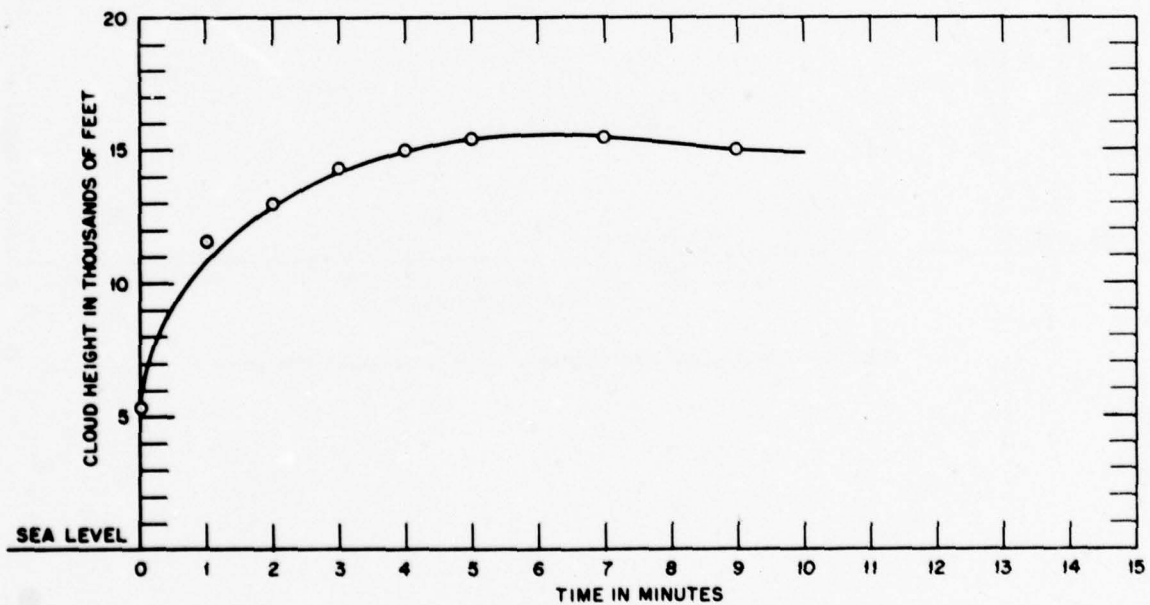


Fig. 27—Cloud height rate-of-growth curve for Tumbler-Snapper 2.

SECRET — SECURITY INFORMATION

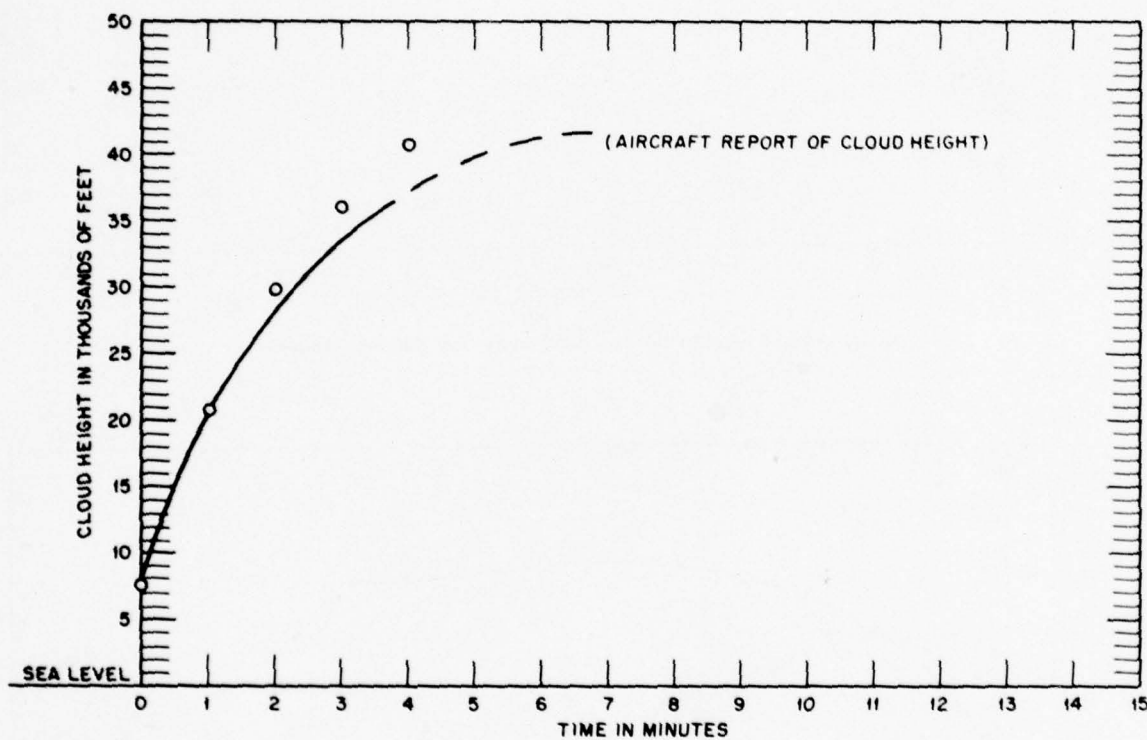


Fig. 28—Cloud height rate-of-growth curve for Tumbler-Snapper 3.

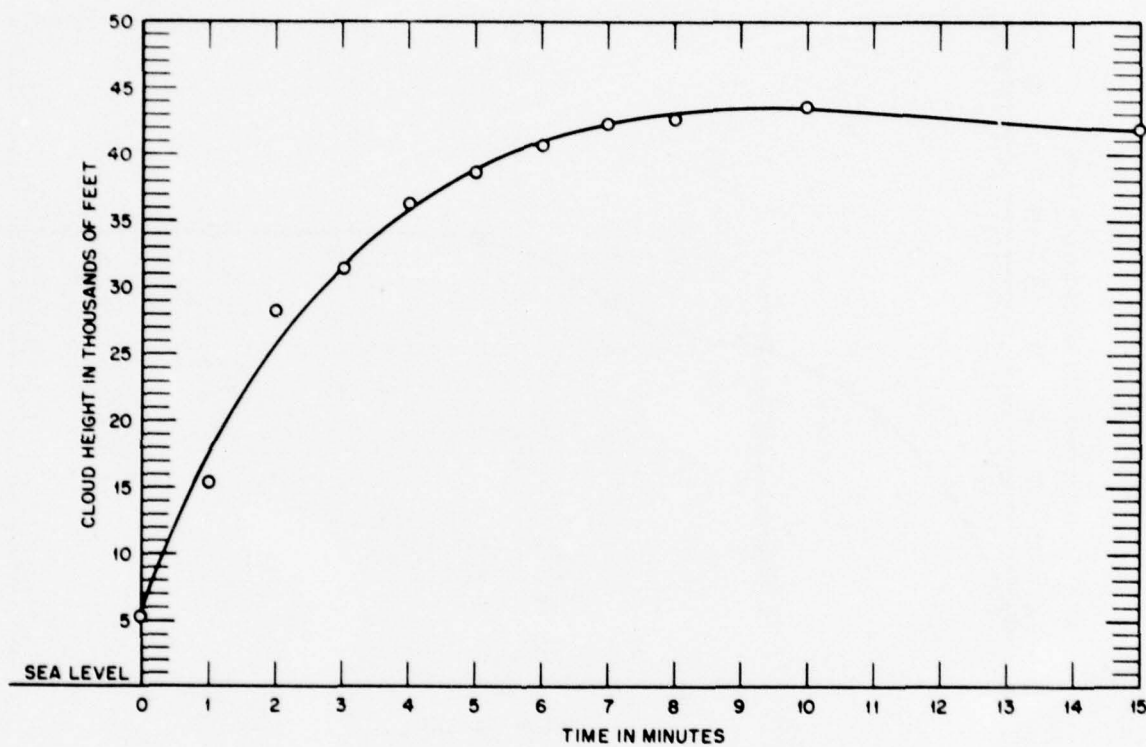


Fig. 29—Cloud height rate-of-growth curve for Tumbler-Snapper 4.

SECRET — SECURITY INFORMATION

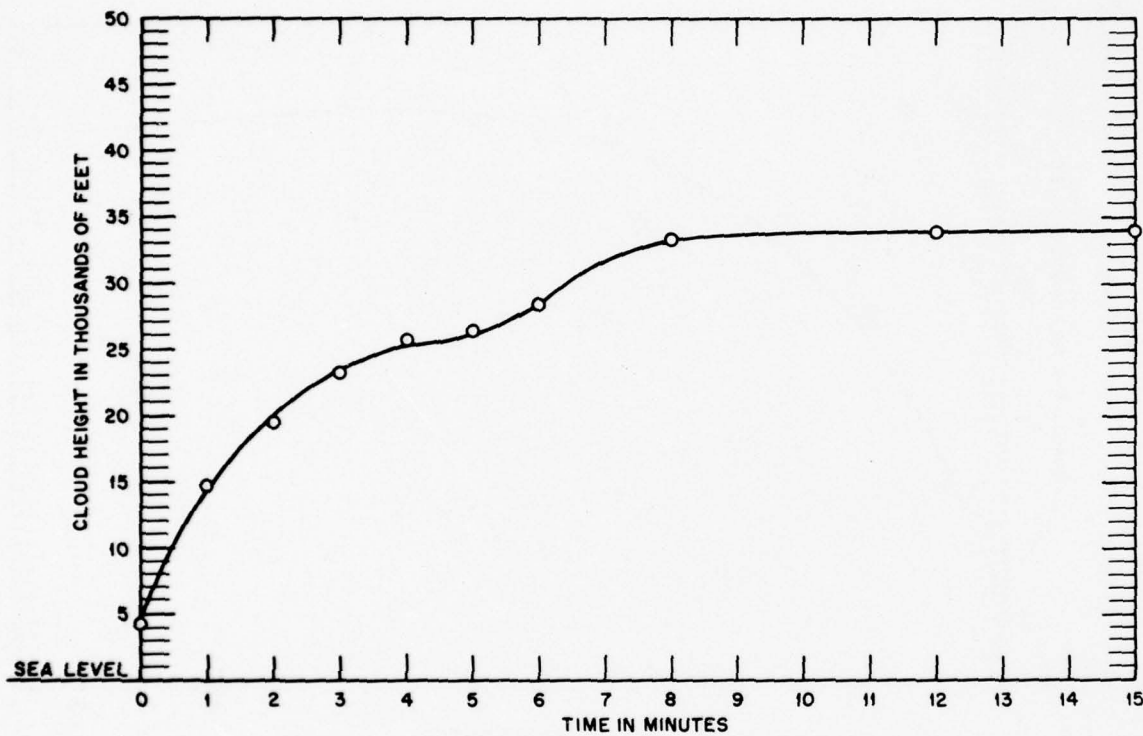


Fig. 30—Cloud height rate-of-growth curve for Tumbler-Snapper 5.

SECRET — SECURITY INFORMATION

SECRET — SECURITY INFORMATION

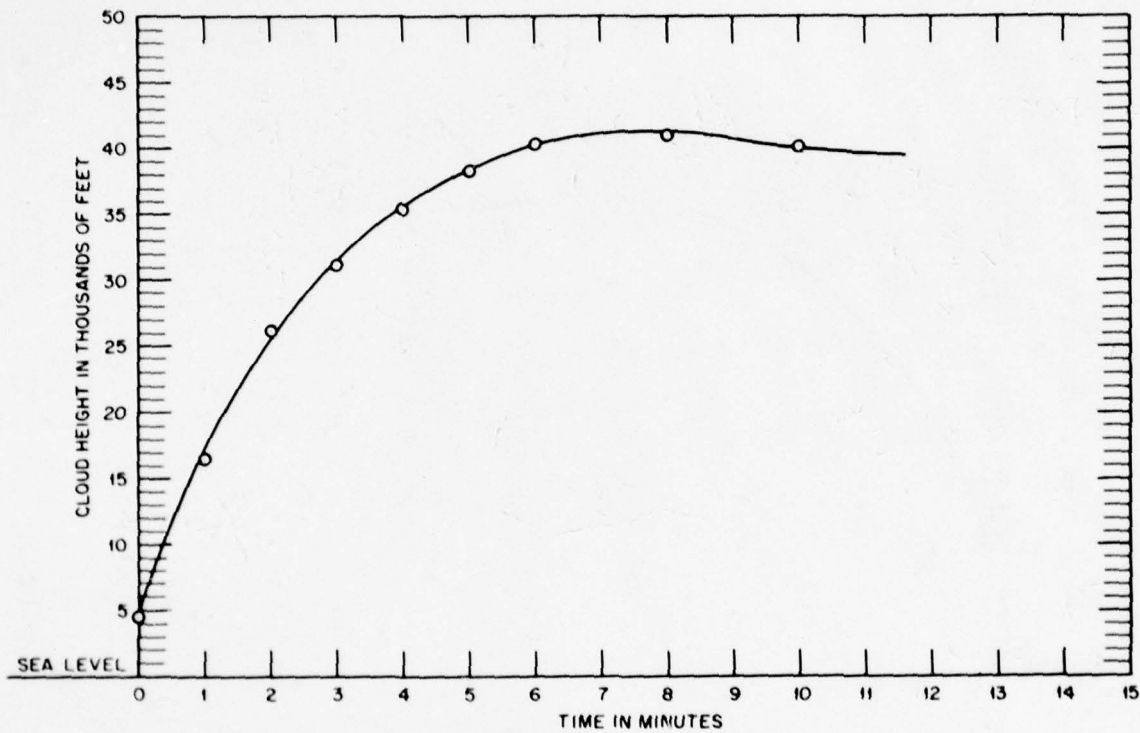


Fig. 31—Cloud height rate-of-growth curve for Tumbler-Snapper 6.

SECRET — SECURITY INFORMATION

SECRET — SECURITY INFORMATION

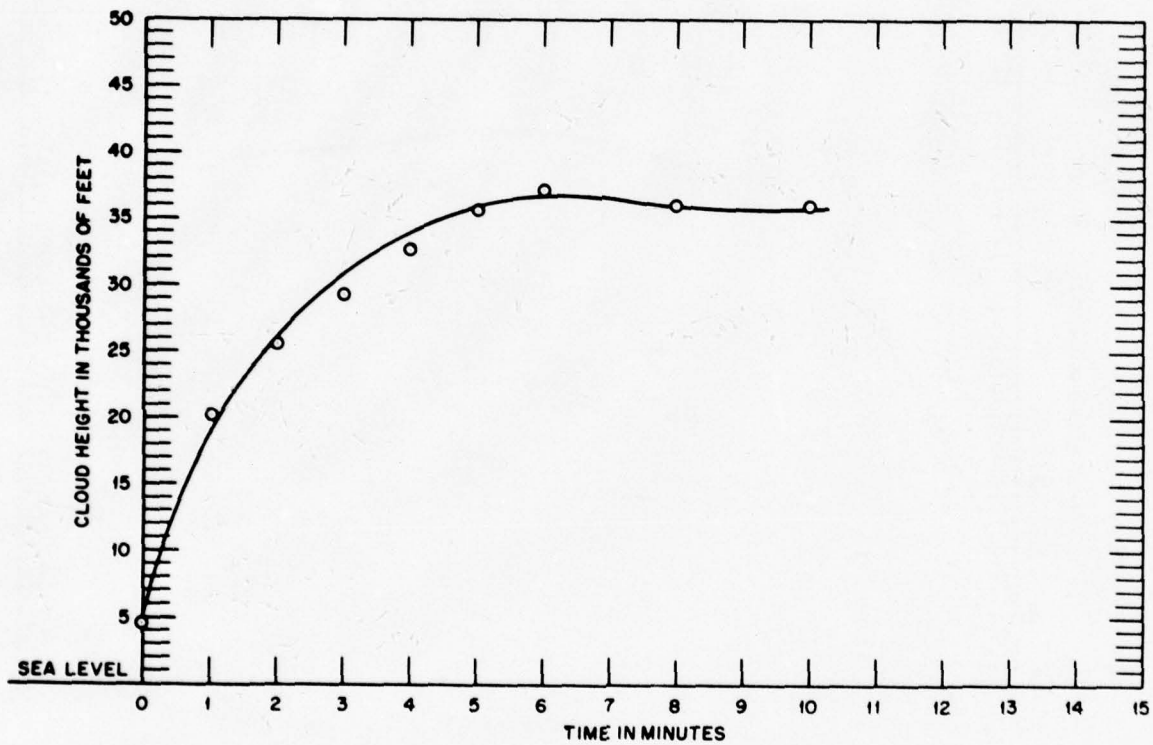


Fig. 32—Cloud height rate-of-growth curve for Tumbler-Snapper 7.

SECRET — SECURITY INFORMATION

SECRET — SECURITY INFORMATION

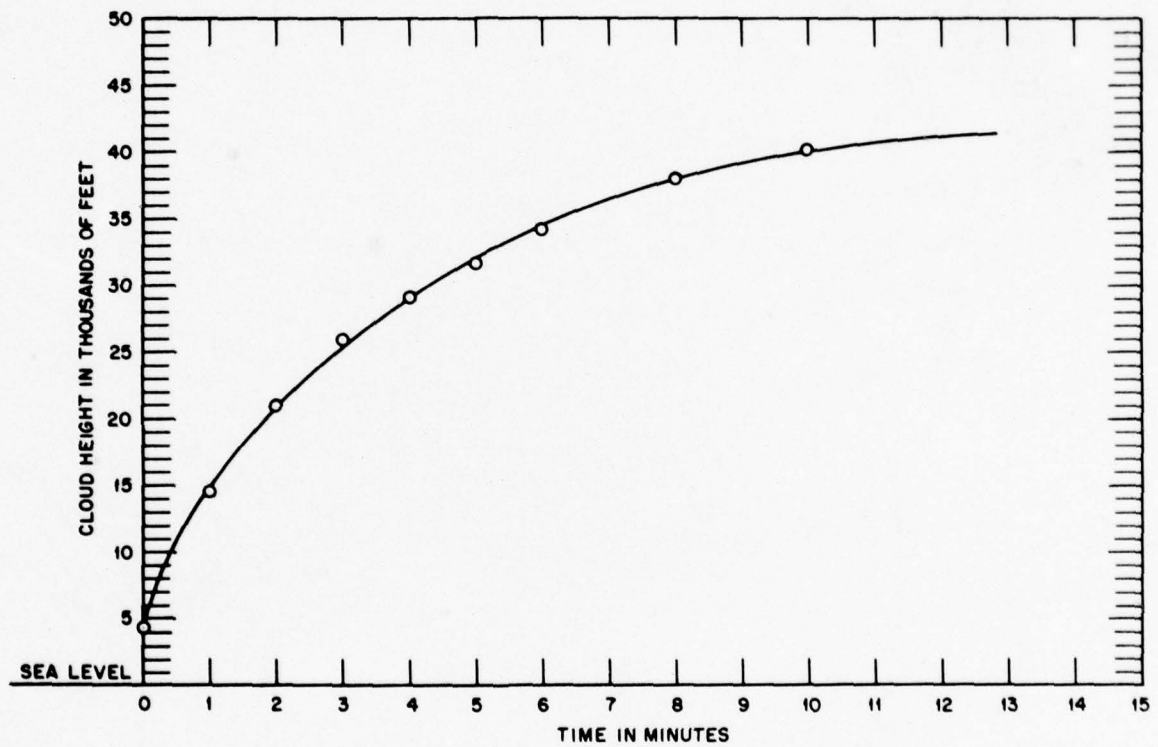
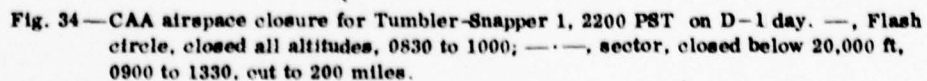


Fig. 33—Cloud height rate-of-growth curve for Tumbler-Snapper 8.

SECRET — SECURITY INFORMATION

**SECRET - SECURITY INFORMATION**



0730 D Day: Flash circle to be held closed until 1330 to cover drift of cloud in SW wind around 10,000 ft. If cloud base goes above 14,000 ft, flash circle will be opened at 1130.

0915 D Day: Because of cloud height (top 16,000 and base 14,000 ft), flash circle will be opened at 1130.

SECRET — SECURITY INFORMATION

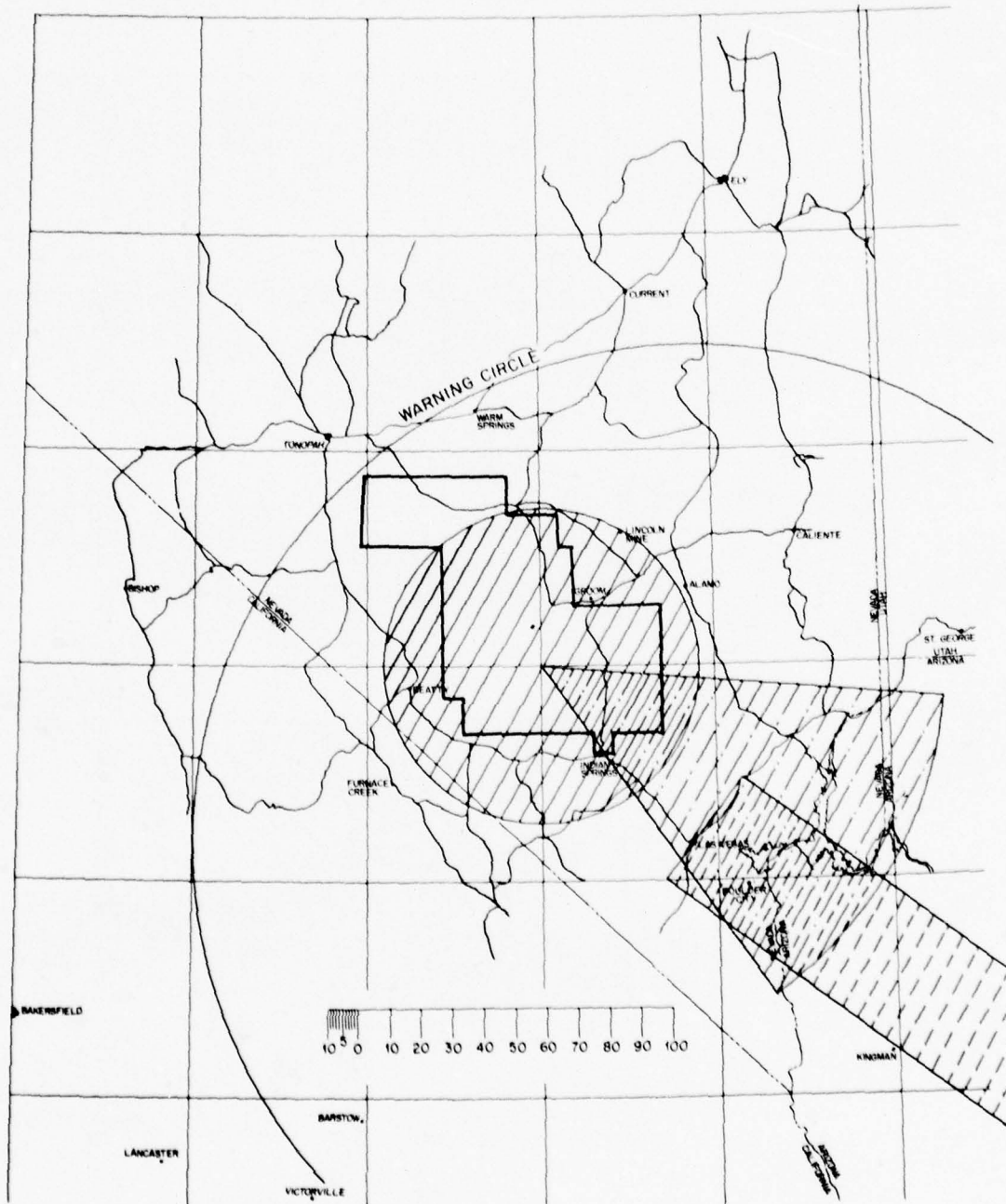


Fig. 35—CAA airspace closure for Tumbler-Snapper 2, 2200 PST on D-1 day. —, Flash circle, closed all altitudes, 0900 to 1130; ---, sector, closed from 10,000 to 20,000 ft, 1000 to 1400; . . . , red 15, closed from 10,000 to 20,000 ft, 1130 to 1930.

SECRET — SECURITY INFORMATION

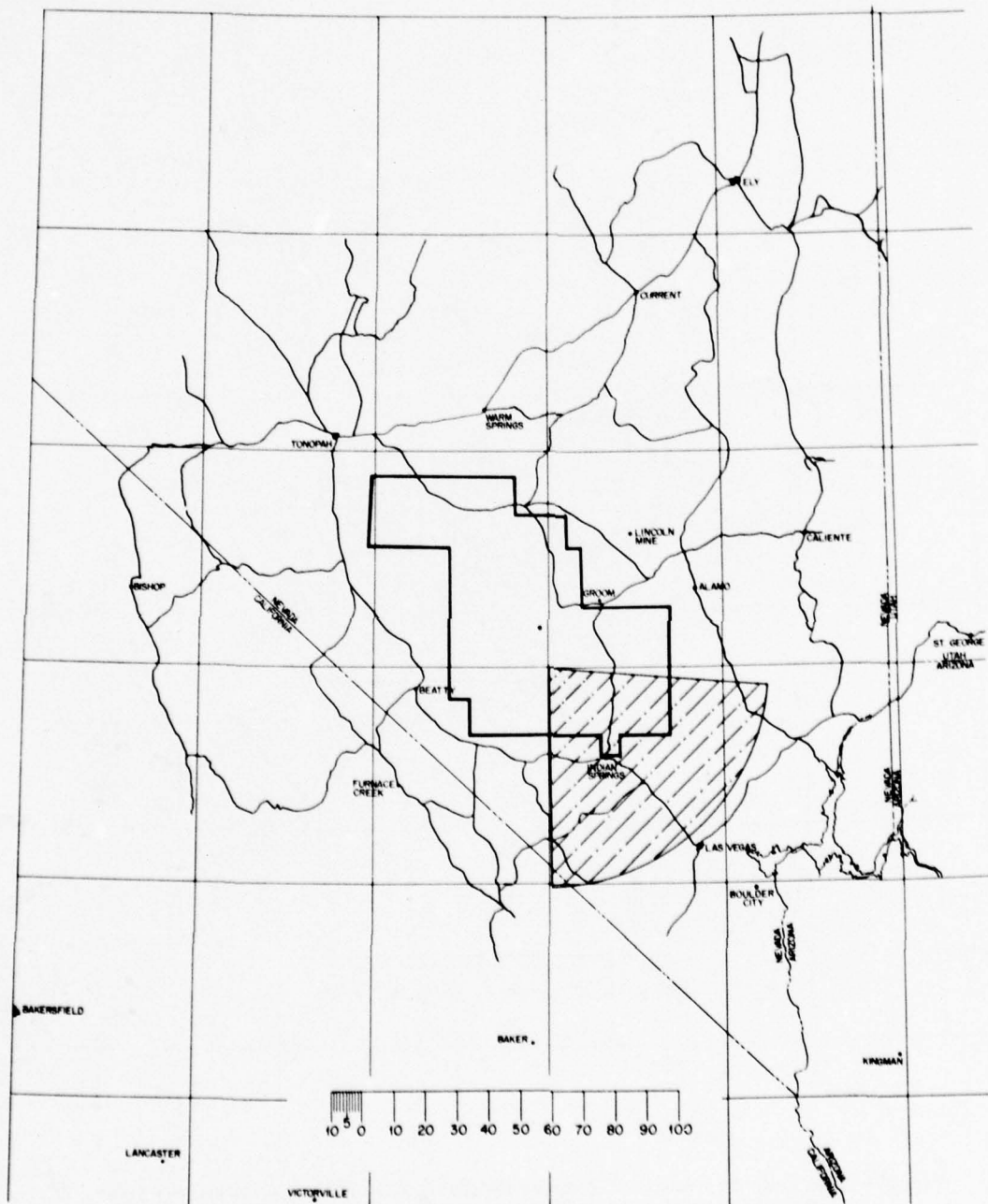


Fig. 36—Change in CAA airspace closure for Tumbler-Snapper 2, prepared at 1200 PST D Day. — · — ·, Sector, closed 10,000 to 20,000 ft until 1400. All other areas open.

SECRET — SECURITY INFORMATION

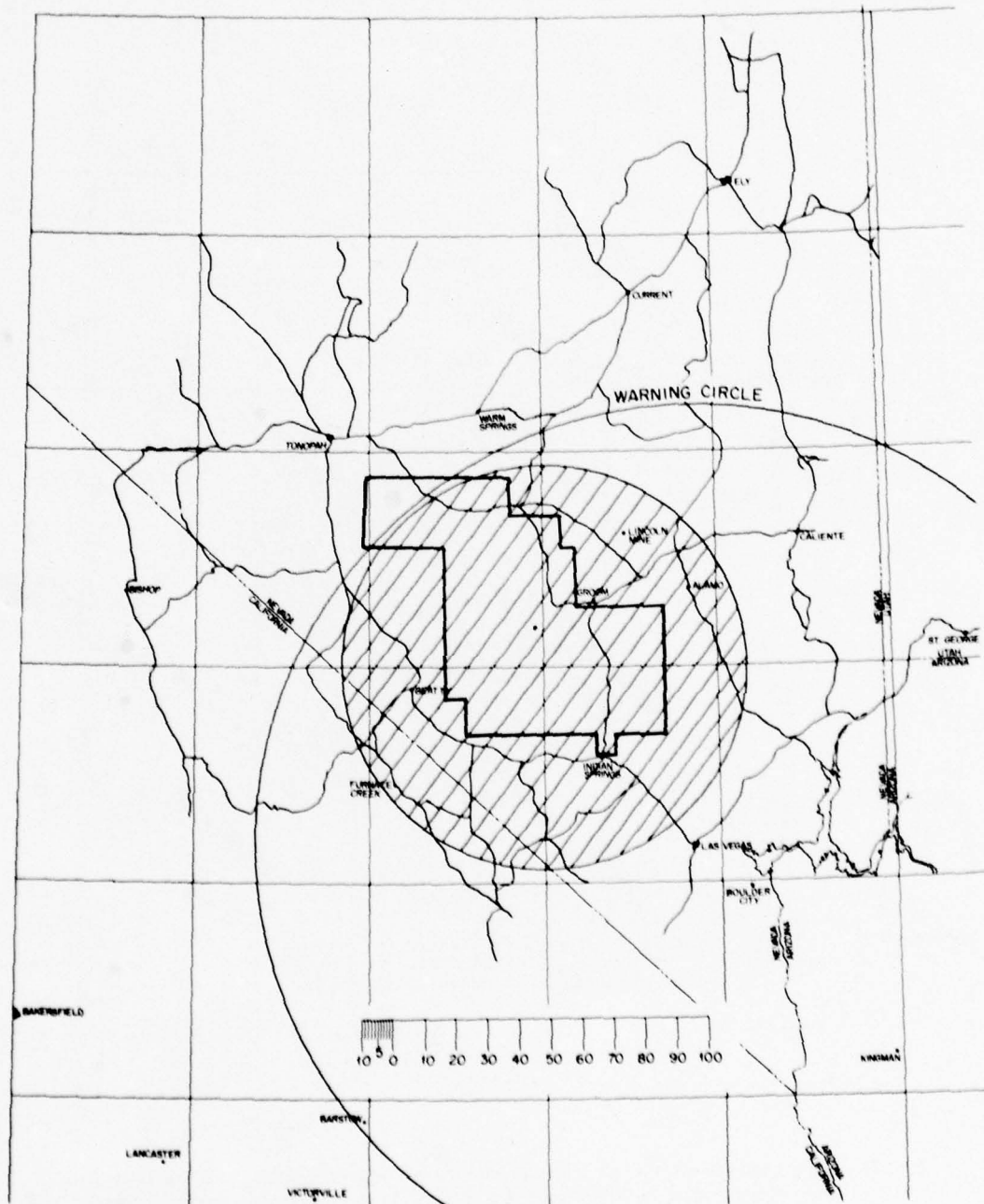


Fig. 37—CAA airspace closure for Tumbler-Snapper 3, prepared at 2200 PST on D-1 day.  
—, Flash circle, closed all altitudes, 0900 to 1200.

**SECRET — SECURITY INFORMATION**

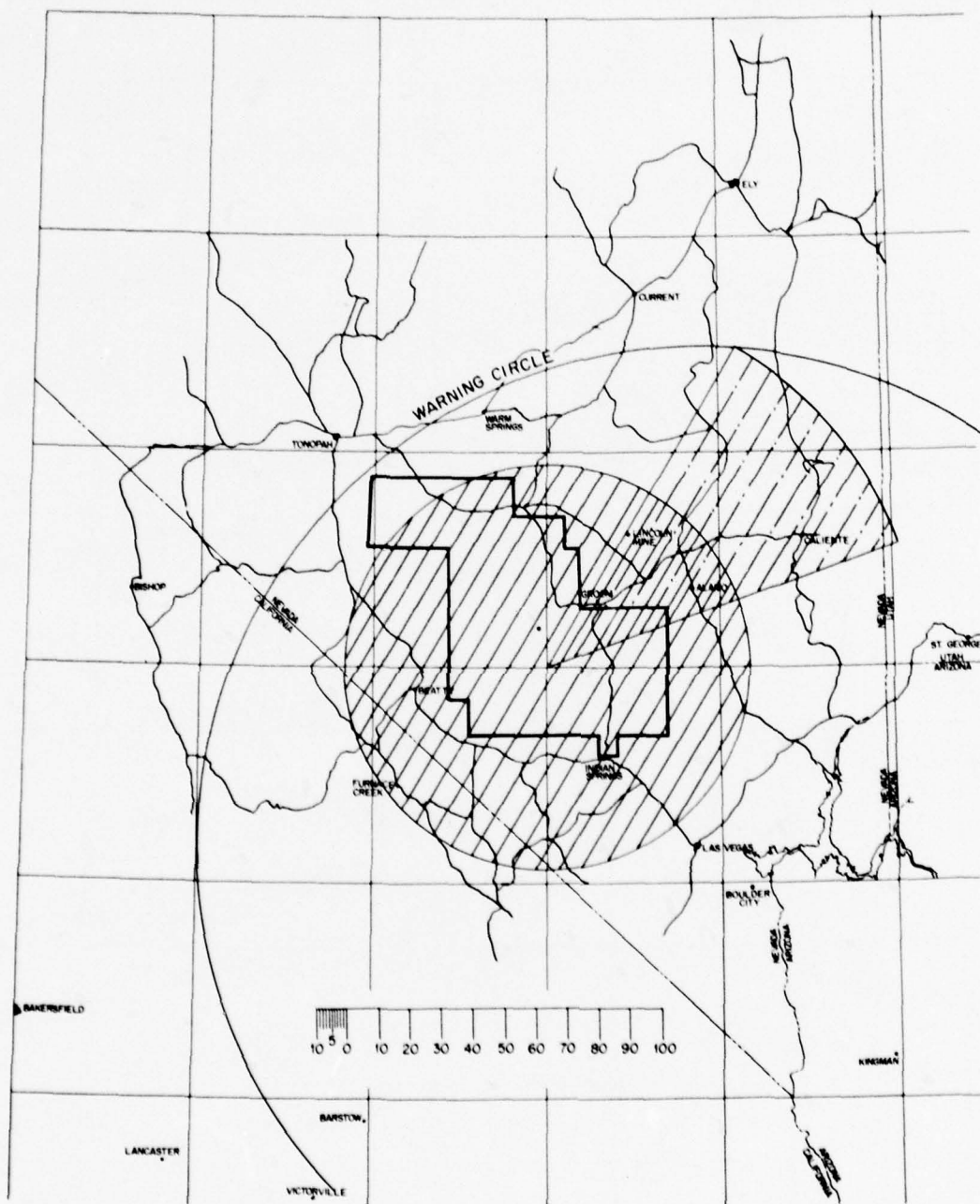


Fig. 38—CAA airspace closure for Tumbler-Snapper 4, prepared at 2300 PDT on D-1 day.  
—, Flash circle, closed all altitudes, 0900 to 1200 PDT; — · —, sector, closed  
10,000 to 35,000 ft, 1000 to 1200 PDT; triangle, 37N 116W-Winslow-Milford,  
closed 35,000 ft and above, 0900 to 1600 PDT.

**Correction to Closure Plan:**

**1200 D Day: Triangle, 35,000 ft and above, closure continued until 1800 PDT.**

SECRET — SECURITY INFORMATION

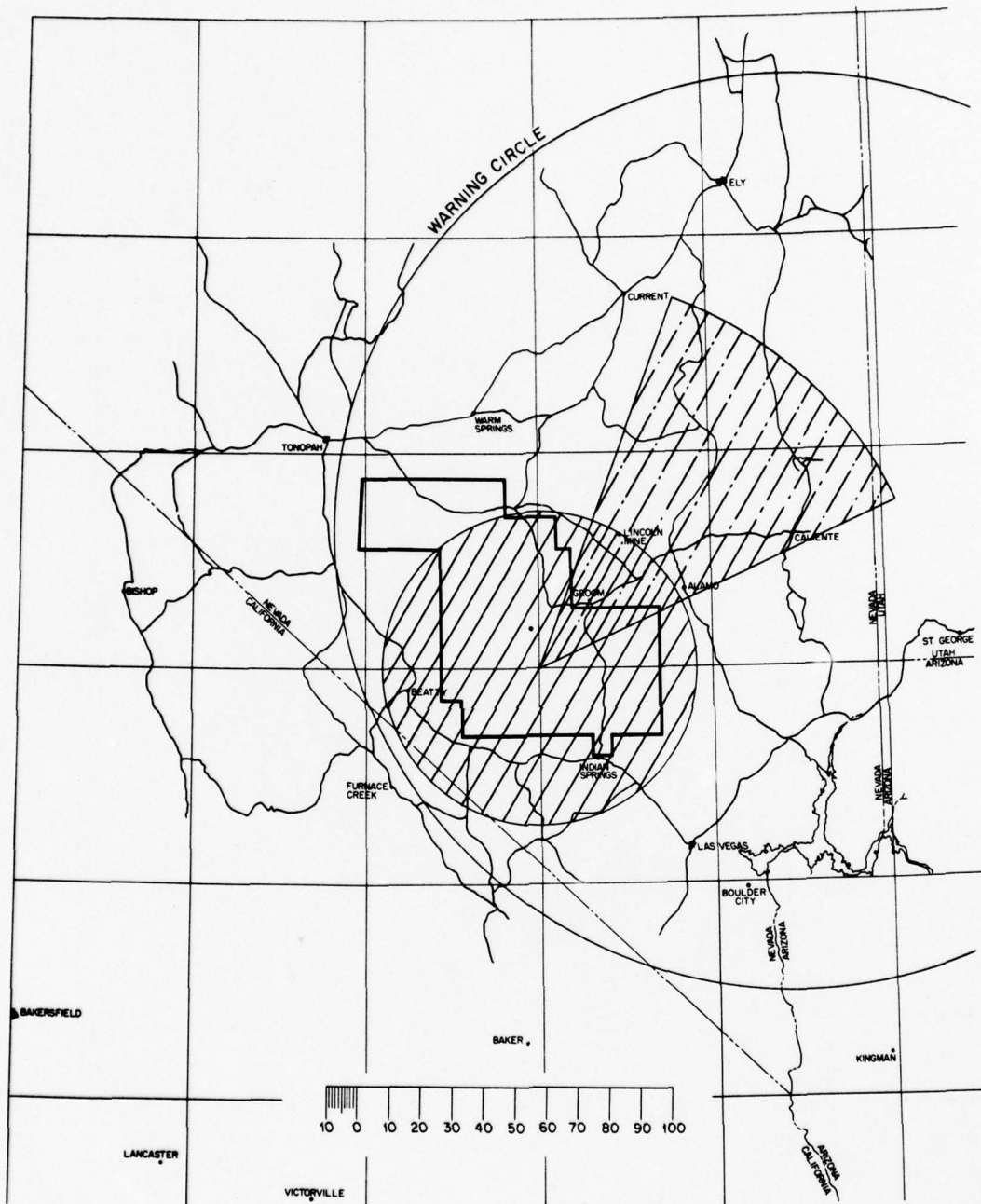


Fig. 39—CAA airspace closure for Tumbler-Snapper 5, prepared 2300 PDT on D-1 day.  
 —, Flash circle, closed all altitudes, 0500 to 0600 PDT; —.—, sector, closed  
 30,000 ft and down, 0500 to 0730 PDT; triangle, Beatty-Denver-Casper, closed  
 31,000 ft and up, 0500 to 1400 PDT.

Correction to Closure Plan:

0600 D Day: Base of high-level triangle lowered to 28,000 ft.

SECRET — SECURITY INFORMATION

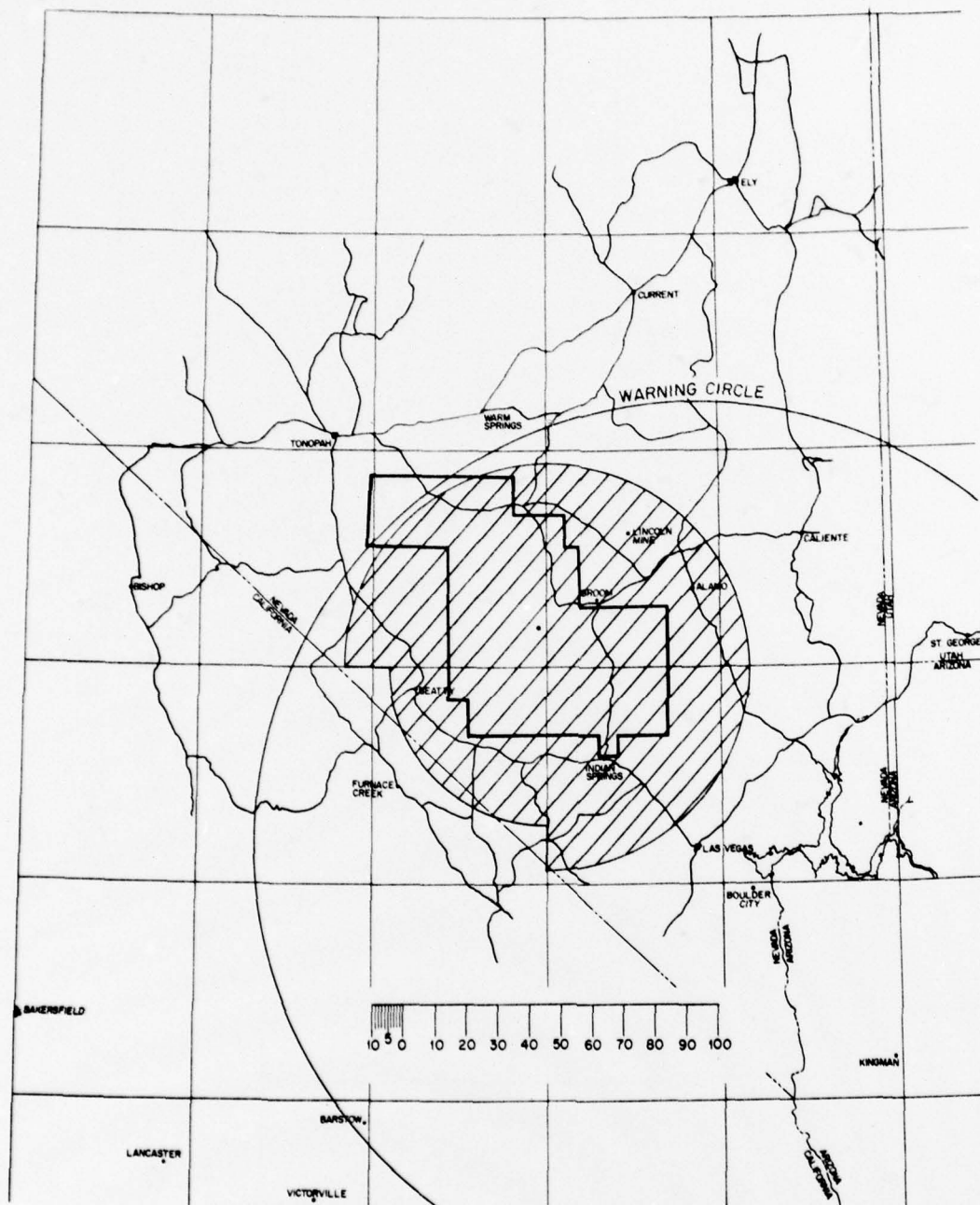


Fig. 40—CAA airspace closure for Tumbler-Snapper 6, prepared at 2300 PDT on D-1 day.  
 —, Flash circle, closed all altitudes, 0430 to 0730 PDT; quadrangle, Las Vegas—  
 Alamogordo—Pueblo—Delta—Las Vegas, closed 31,000 ft and up, 0630 to 2000 PDT.

Correction to Closure Plan:

0730 D Day: Northeast quadrant of flash circle continued closed until 0930 PDT, based on  
 air readings of 10 r between Groom Mine and Crystal Springs.

SECRET — SECURITY INFORMATION

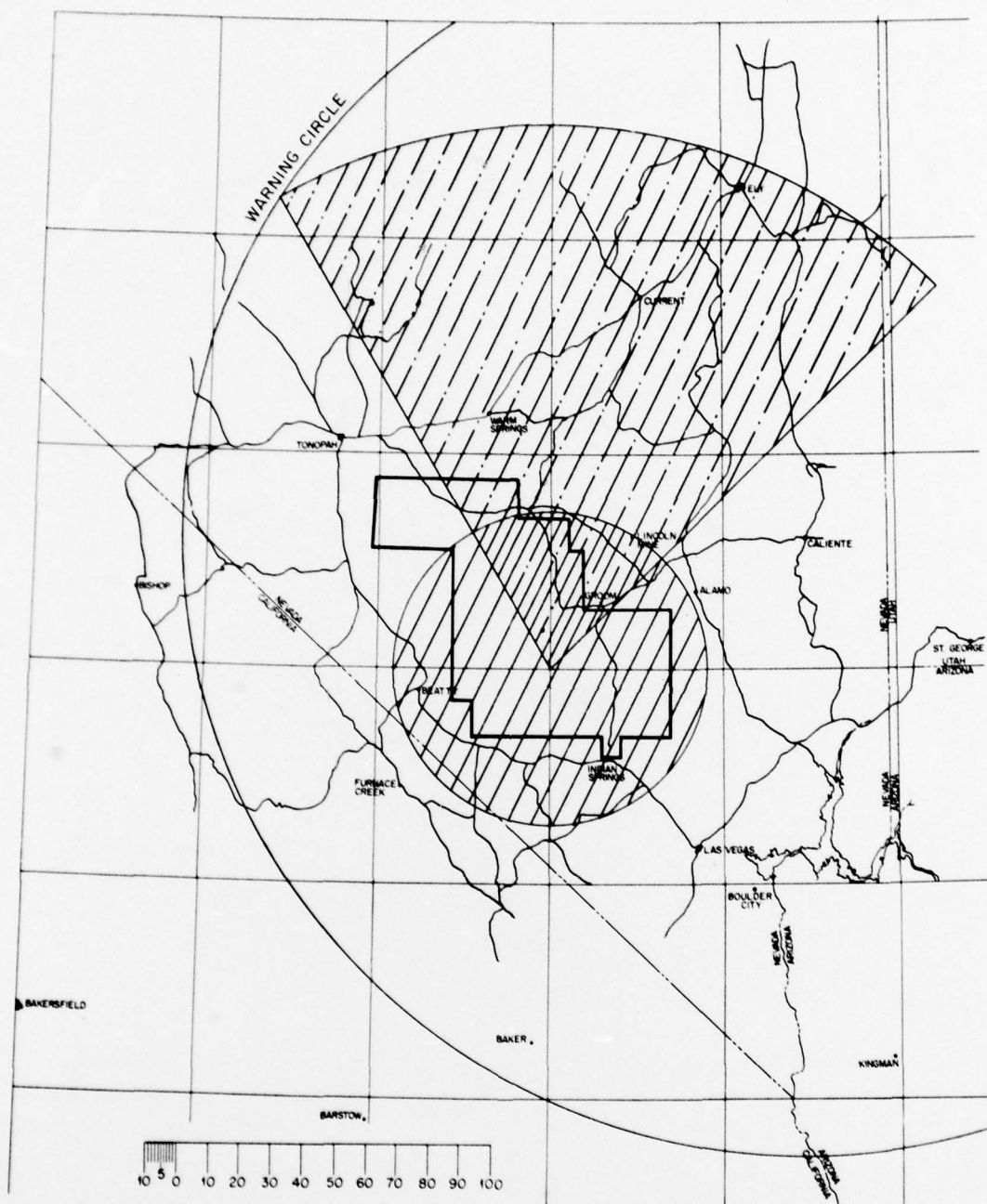


Fig. 41—CAA airspace closure for Tumbler-Snapper 7, prepared at 2300 PDT on D-1 day.  
 —, Flash circle, closed all altitudes, 0400 to 0630 PDT; — · —, sector, closed all altitudes, 0630 to 1700 PDT.

Correction to Closure Plan:

0700 D Day: Quadrangle, Las Vegas-Salt Lake City-Burley-Battle Mountain, closed 31,000 ft and up until 1700 PDT. Altitudes 30,000 ft and down open after 0930 PDT in all sectors.

SECRET — SECURITY INFORMATION

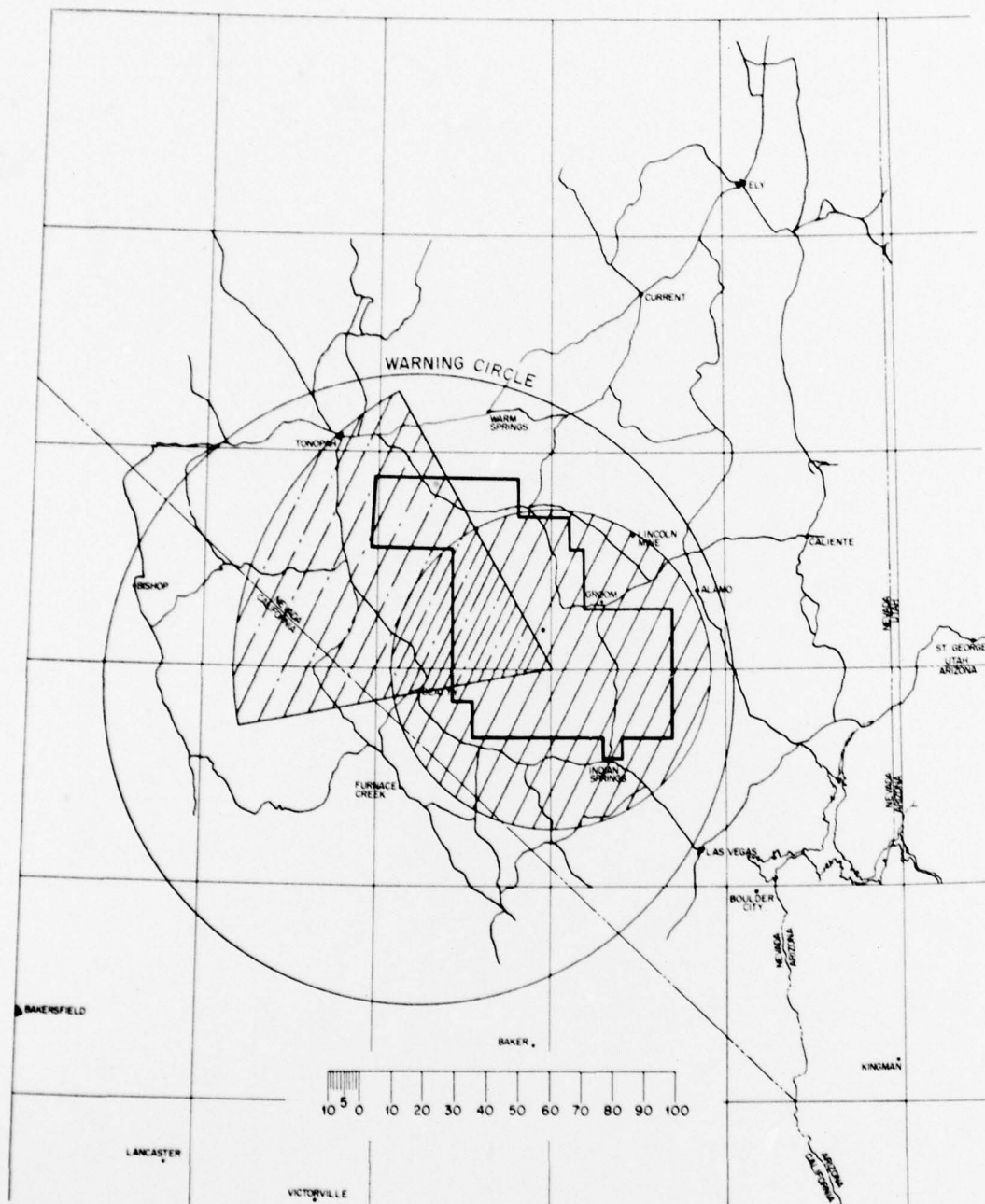


Fig. 42—CAA airspace closure for Tumbler-Snapper 8, prepared at 2300 PDT on D-1 day.  
 —, Flash circle, closed all altitudes, 0400 to 0630 PDT; - - -, sector, closed all altitudes, 0630 to 1030 PDT; quadrangle, Las Vegas-Rome-Klamath Falls-Fresno, closed 26,000 ft and up, 0600 to 2000 PDT.

Correction to Closure Plan:

0530 D Day: Quadrangle shifted to Las Vegas-Albuquerque-Denver-Wendover, times and heights unchanged.

SECRET — SECURITY INFORMATION

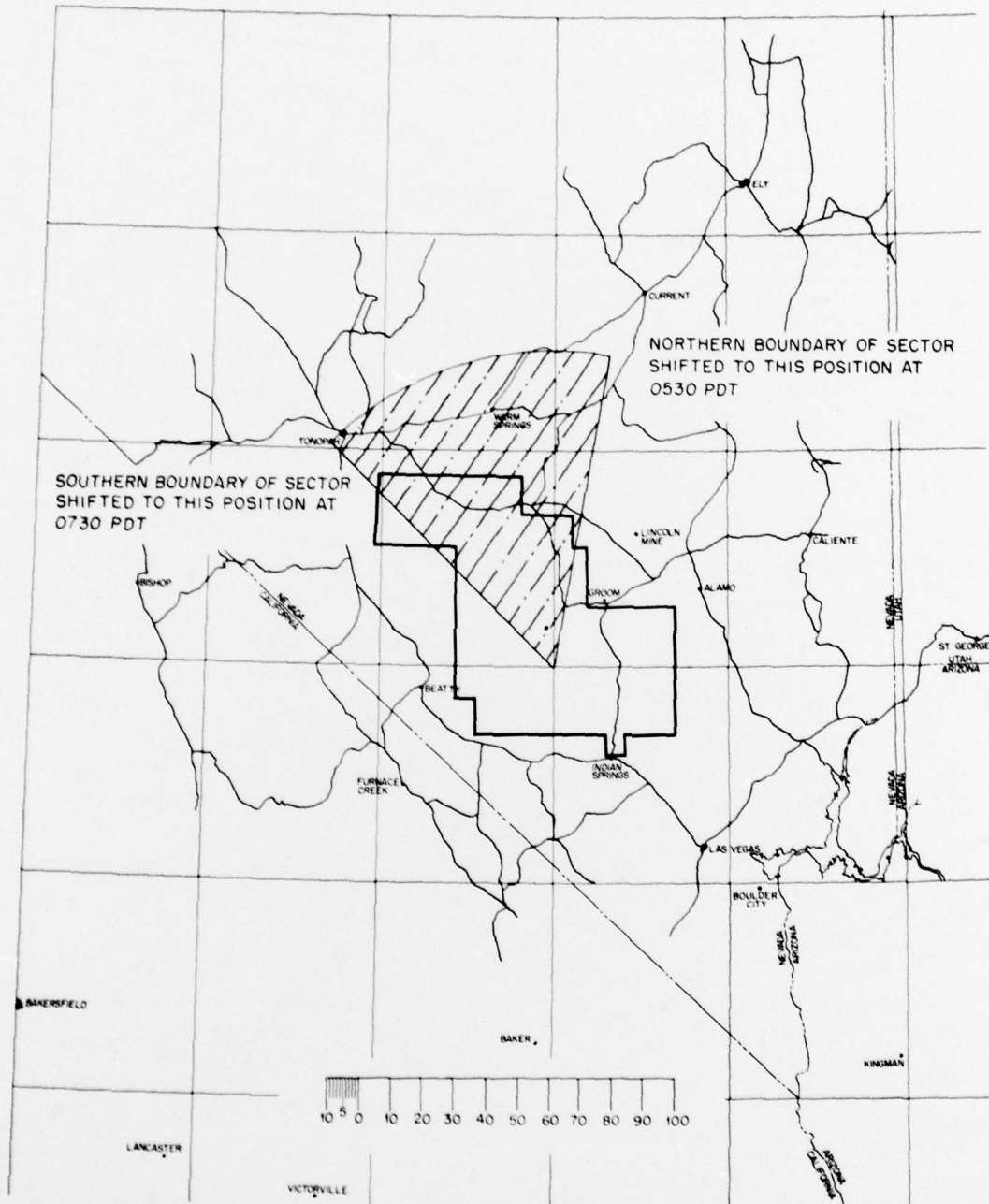


Fig. 43—Change in CAA airspace closure for Tumbler-Snapper 8, prepared at times as indicated. —.—, Sector, closed all altitudes.

SECRET — SECURITY INFORMATION

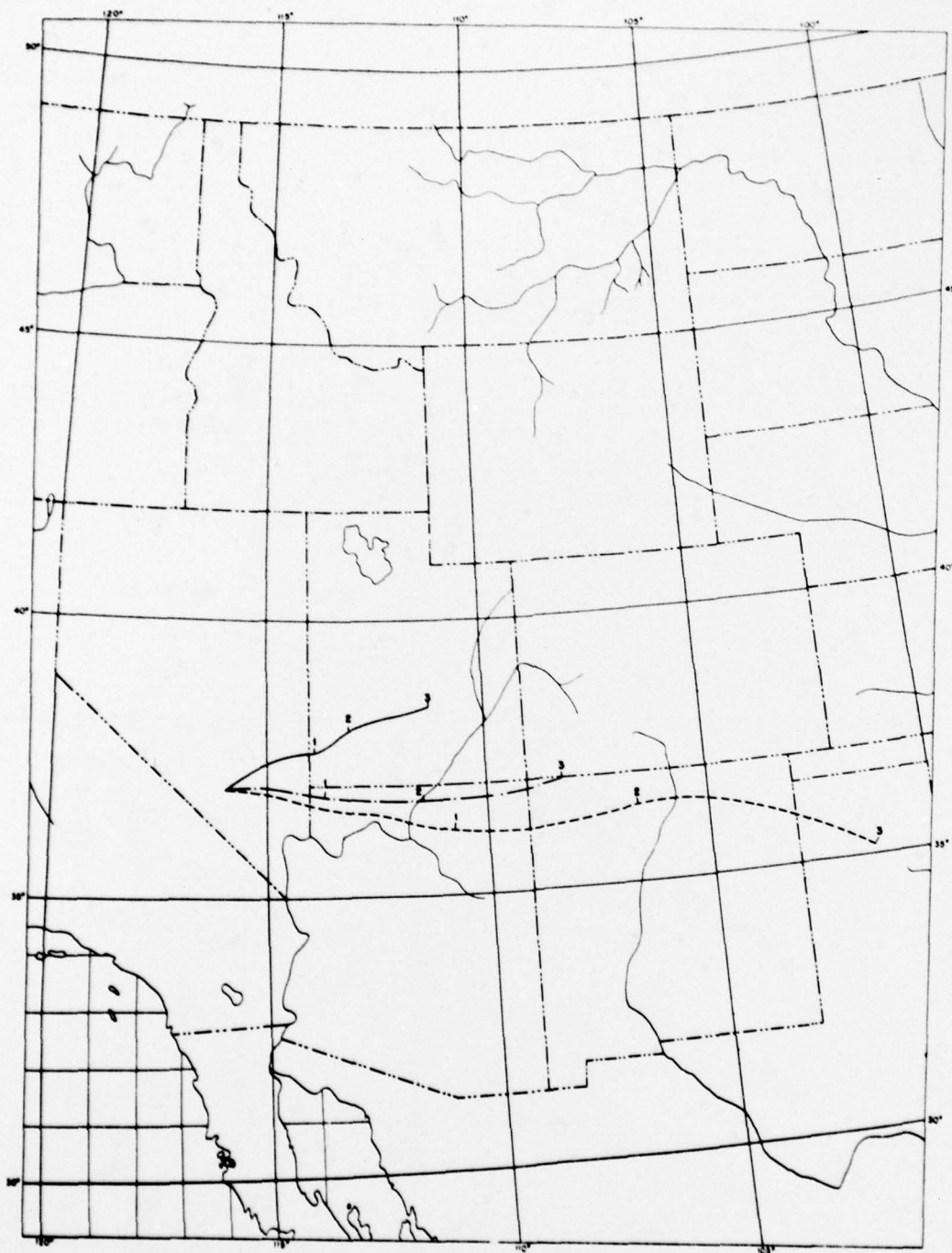


Fig. 44—Cloud trajectories for Tumbler-Tracker 1. —, 10,000-ft trajectory; - - -, 15,000-ft trajectory; . . . , 20,000-ft trajectory. 1, 0000Z 2 April (1800 PST 1 April). 2, 0600Z 2 April (2200 PST 1 April). 3, 1200Z 2 April (0400 PST 2 April).

SECRET — SECURITY INFORMATION

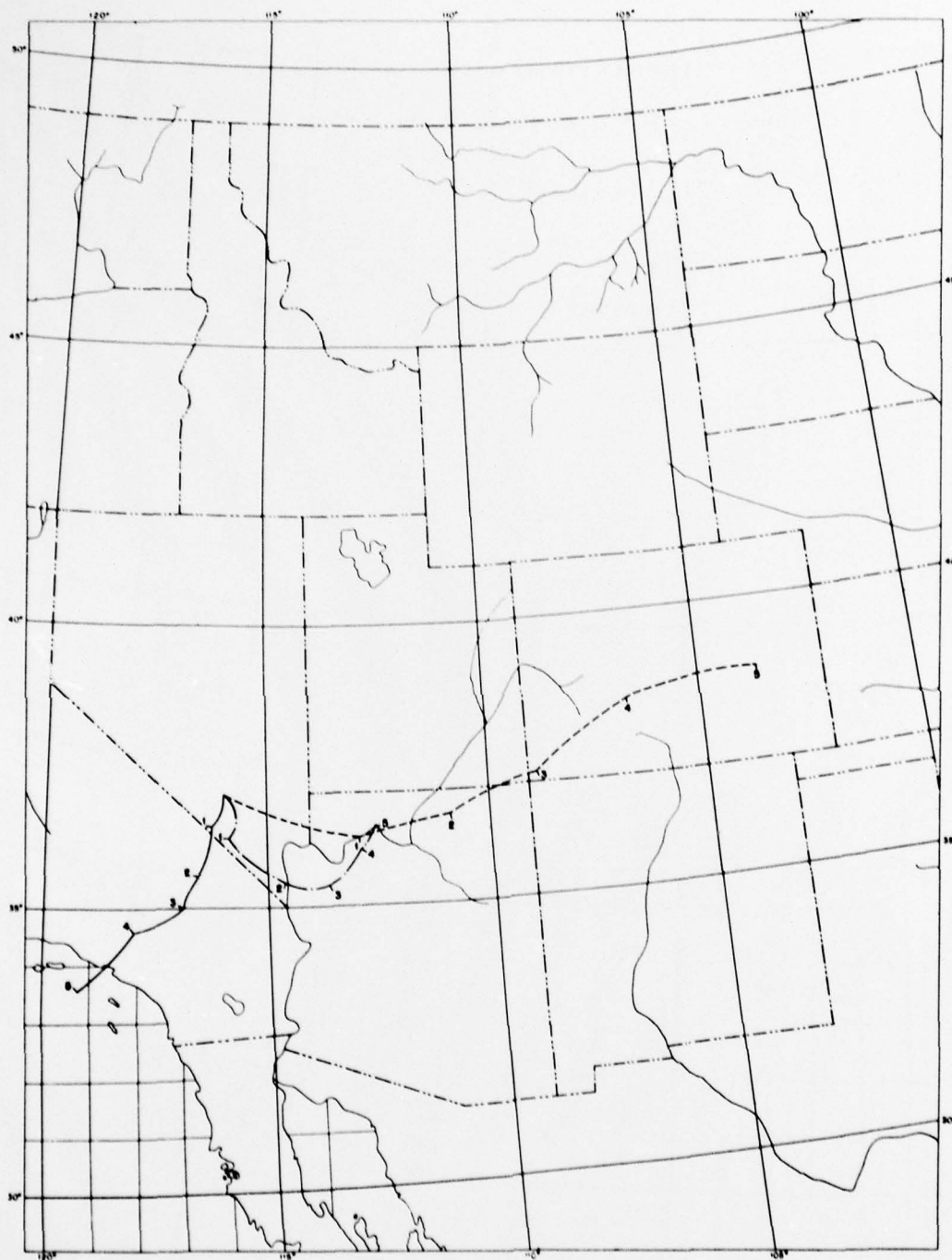


Fig. 45—Cloud trajectories for Tumbler-Snapper 2. —, 10,000-ft trajectory; - - -, 15,000-ft trajectory; - · - ·, 20,000-ft trajectory. 1, 0000Z 16 April (1600 PST 15 April). 2, 0600Z 16 April (2200 PST 15 April). 3, 1200Z 16 April (0400 PST 16 April). 4, 1800Z 16 April (1000 PST 16 April). 5, 0000Z 17 April (1600 PST 16 April).

SECRET — SECURITY INFORMATION

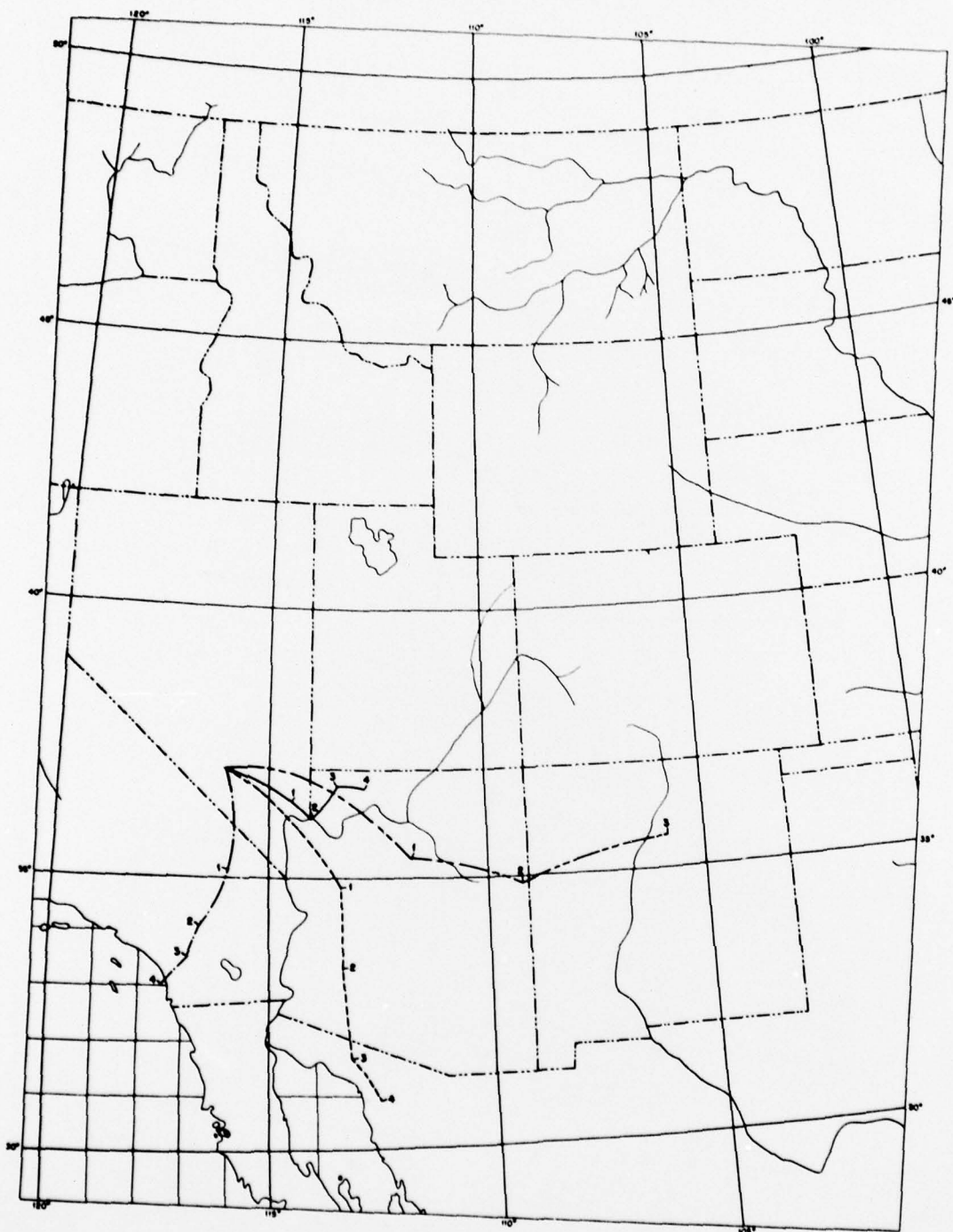


Fig. 46—Cloud trajectories for Tumbler-Snapper 3. —, 10,000-ft trajectory; - - -, 20,000-ft trajectory; - · - ·, 30,000-ft trajectory; - - - -, 40,000-ft trajectory. 1, 0000Z 23 April (1600 PST 22 April). 2, 0800Z 23 April (2200 PST 22 April). 3, 1200Z 23 April (0400 PST 23 April). 4, 1800Z 23 April (1000 PST 23 April).

SECRET — SECURITY INFORMATION

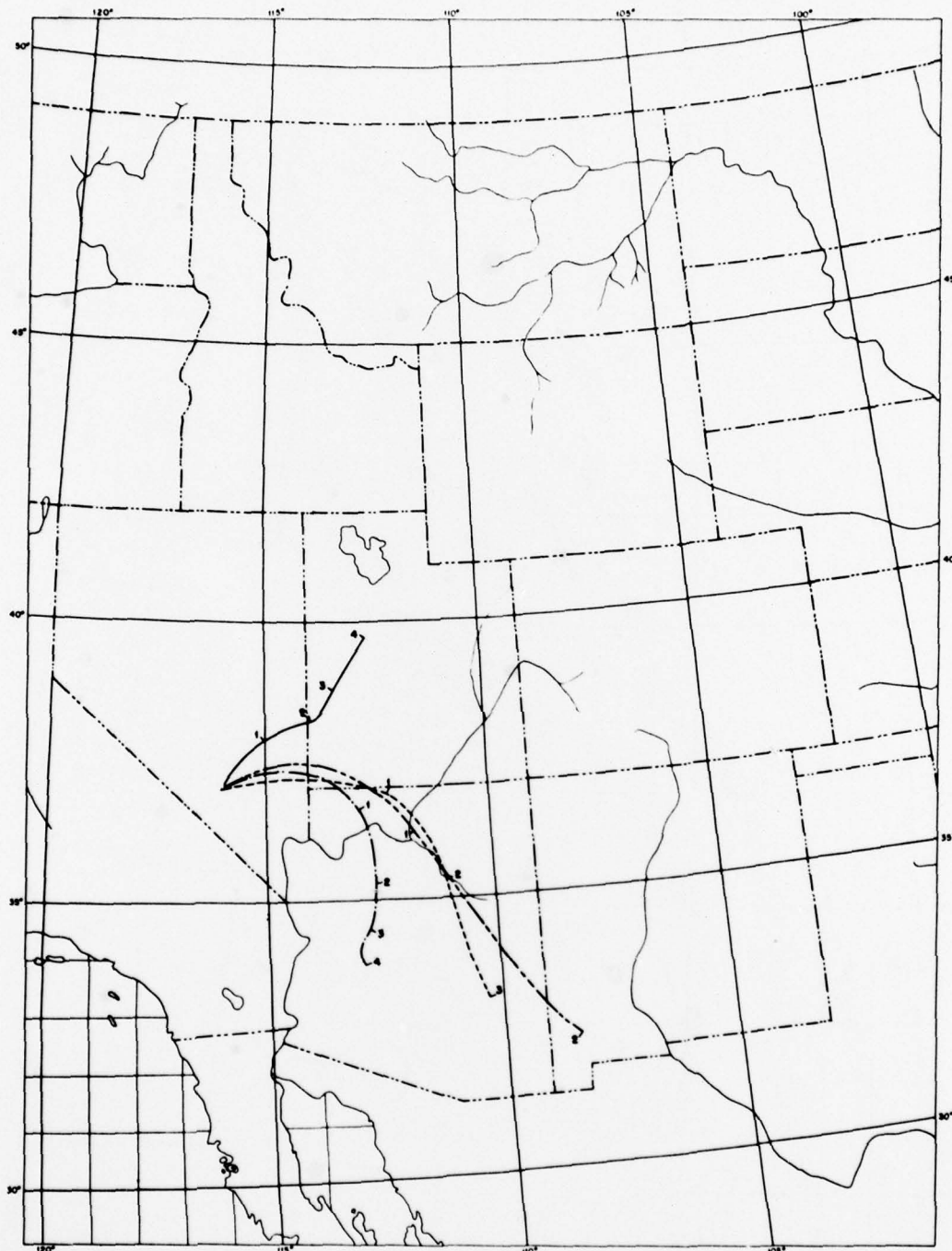


Fig. 47—Cloud trajectories for Tumbler-Snapper 4. —, 10,000-ft trajectory; —·—, 20,000-ft trajectory; - - - - , 30,000-ft trajectory; - - - - - , 40,000-ft trajectory. 1, 0000Z 2 May (1600 PDT 1 May). 2, 0600Z 2 May (2200 PDT 1 May). 3, 1200Z 2 May (0400 PDT 2 May). 4, 1800Z 2 May (1000 PDT 2 May).

UNCLASSIFIED

~~SECRET~~ ~~SECURITY INFORMATION~~

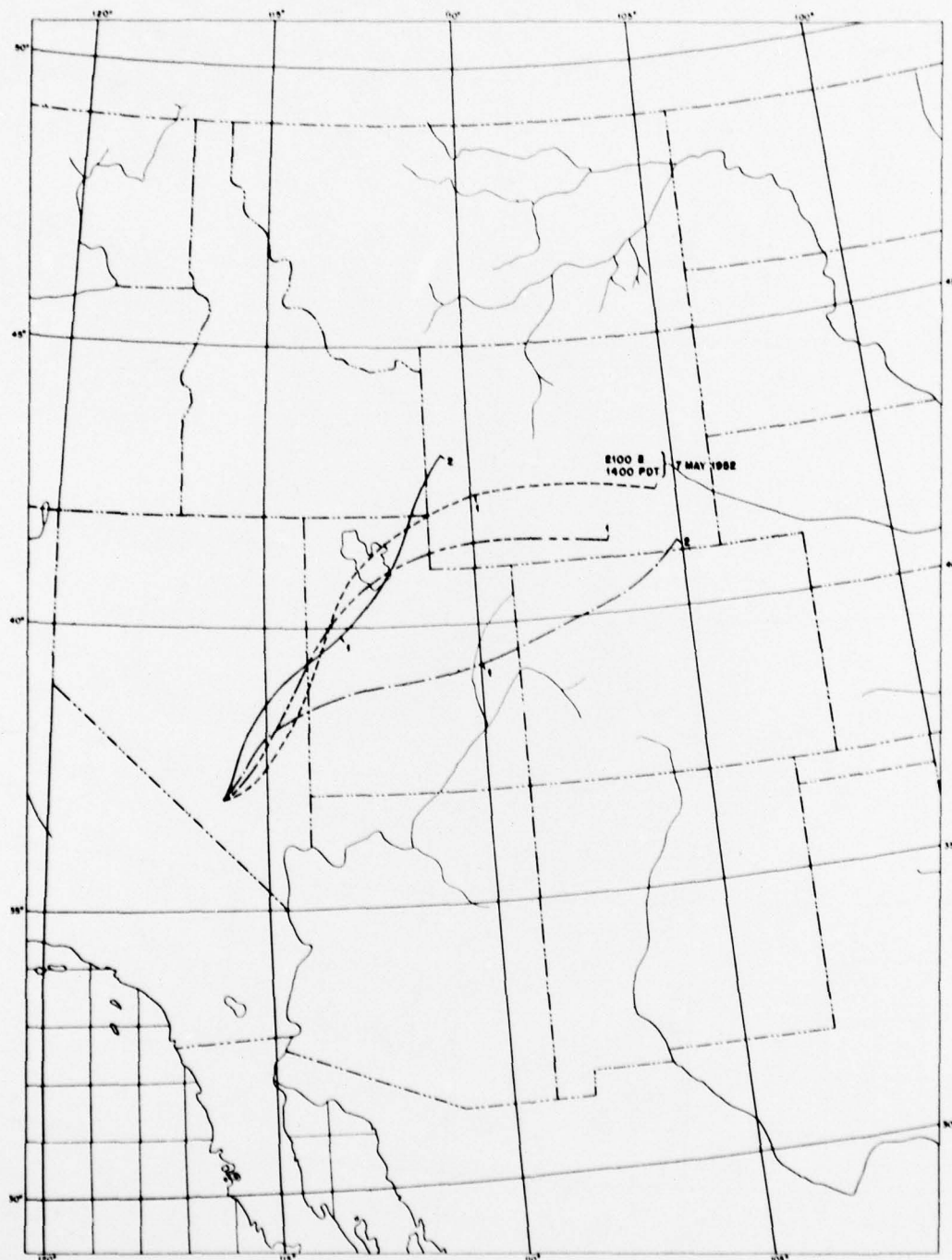


Fig. 48—Cloud trajectories for Tumbler-Snapper 5. —, 10,000-ft trajectory; - - -, 20,000-ft trajectory; - - - -, 30,000-ft trajectory; - · - · -, 40,000-ft trajectory. 1, 1800Z 7 May (1100 PDT 7 May). 2, 0000Z 8 May (1700 PDT 7 May).

~~SECRET~~ ~~SECURITY INFORMATION~~

UNCLASSIFIED

UNCLASSIFIED

~~SECRET SECURITY INFORMATION~~

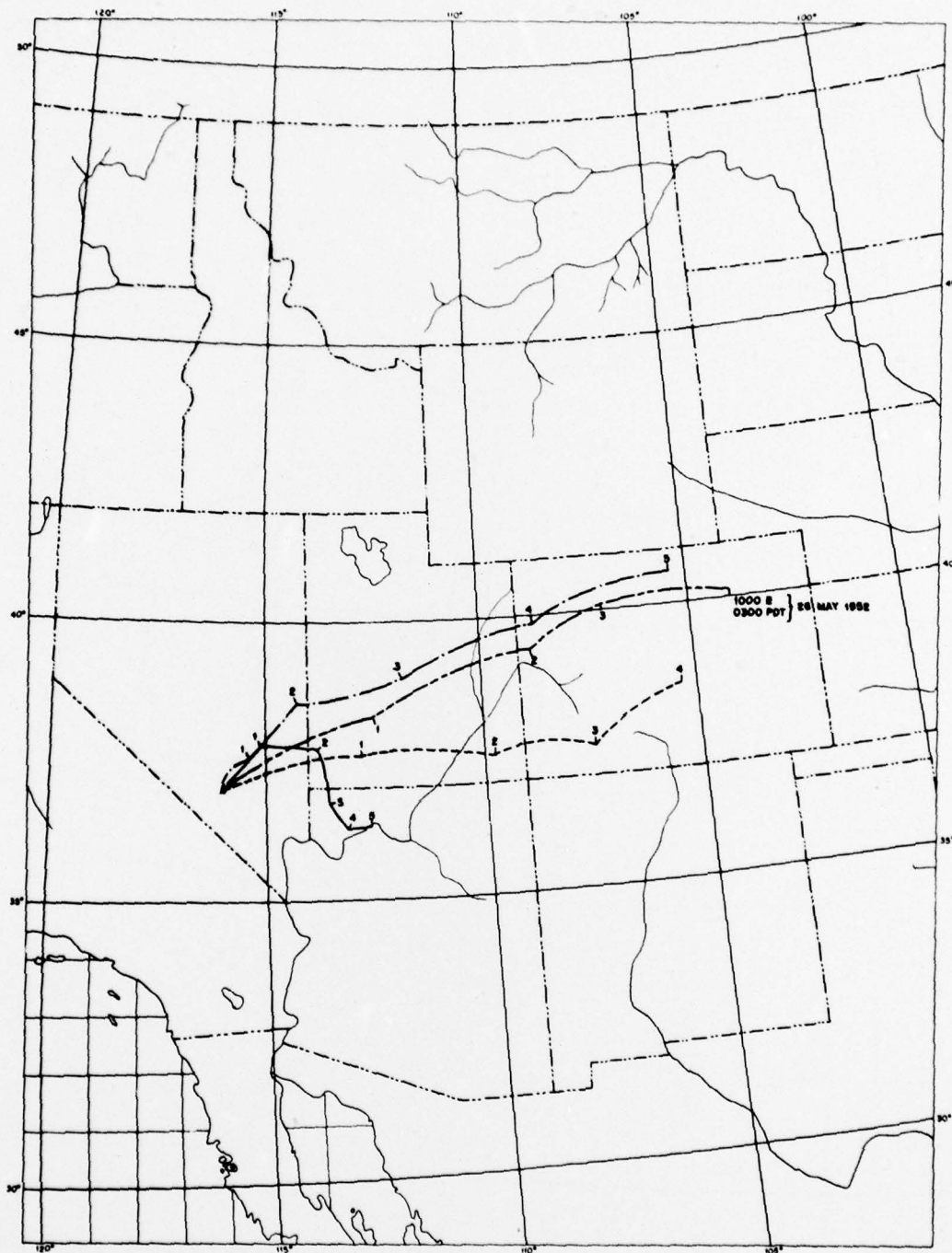


Fig. 49—Cloud trajectories for Tumbler-Snapper 8. —, 10,000-ft trajectory; - - -, 20,000-ft trajectory; - - - -, 30,000-ft trajectory; - - - - -, 40,000-ft trajectory. 1, 1800Z 25 May (1100 PDT 25 May). 2, 0000Z 26 May (1700 PDT 25 May). 3, 0600Z 26 May (2300 PDT 25 May). 4, 1200Z 26 May (0500 PDT 26 May). 5, 1800Z 26 May (1100 PDT 26 May).

~~SECRET SECURITY INFORMATION~~

UNCLASSIFIED

SECRET — SECURITY INFORMATION

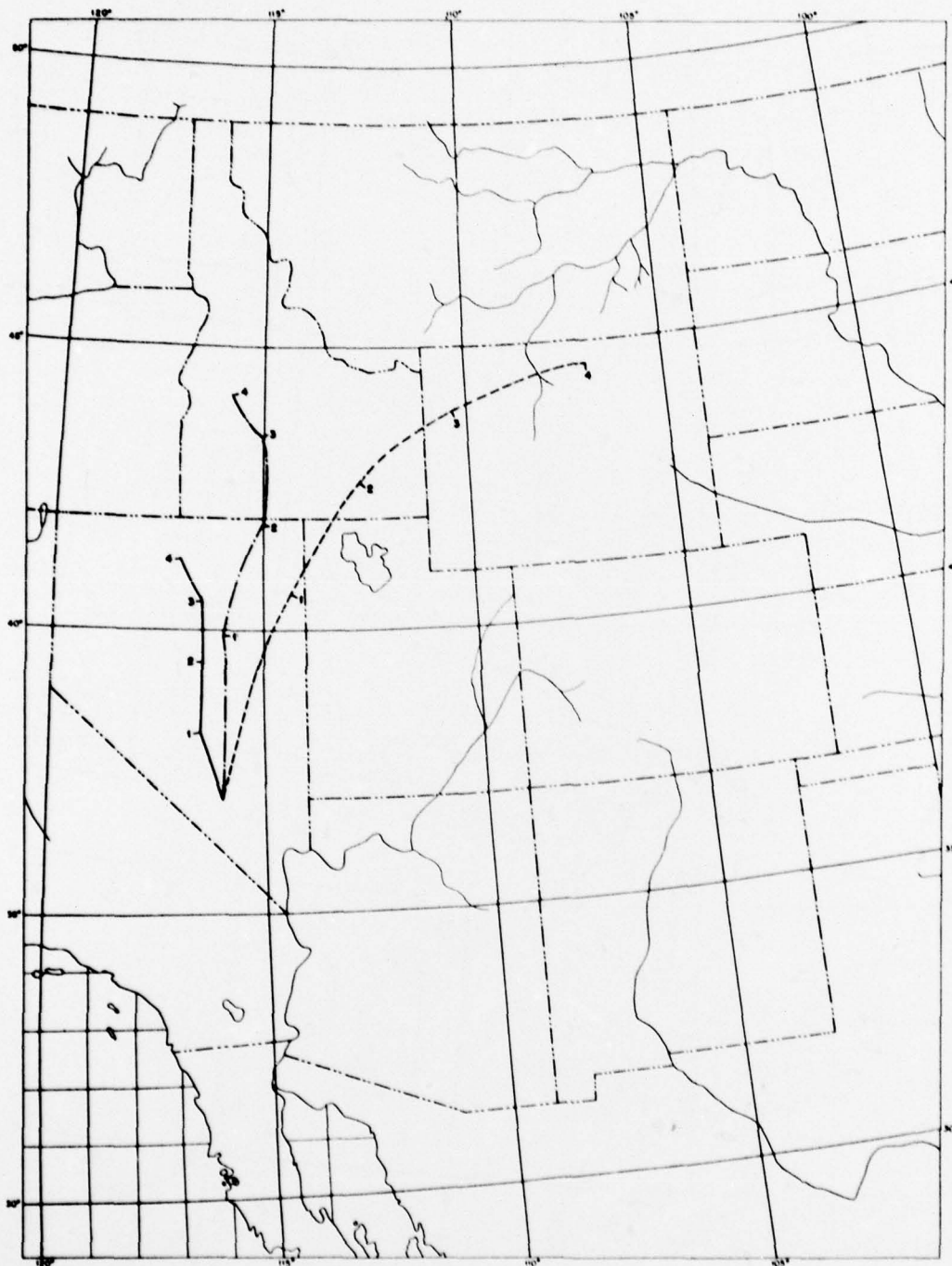


Fig. 50—Cloud trajectories for Tumbler-Tracker 7. —, 10,000-ft trajectory; ---, 20,000-ft trajectory; - . - ., 30,000-ft trajectory. 1, 1800Z 1 June (1100 PDT 1 June). 2, 0000Z 2 June (1700 PDT 1 June). 3, 0600Z 2 June (2300 PDT 1 June). 4, 1200Z 2 June (0500 PDT 2 June).

SECRET — SECURITY INFORMATION

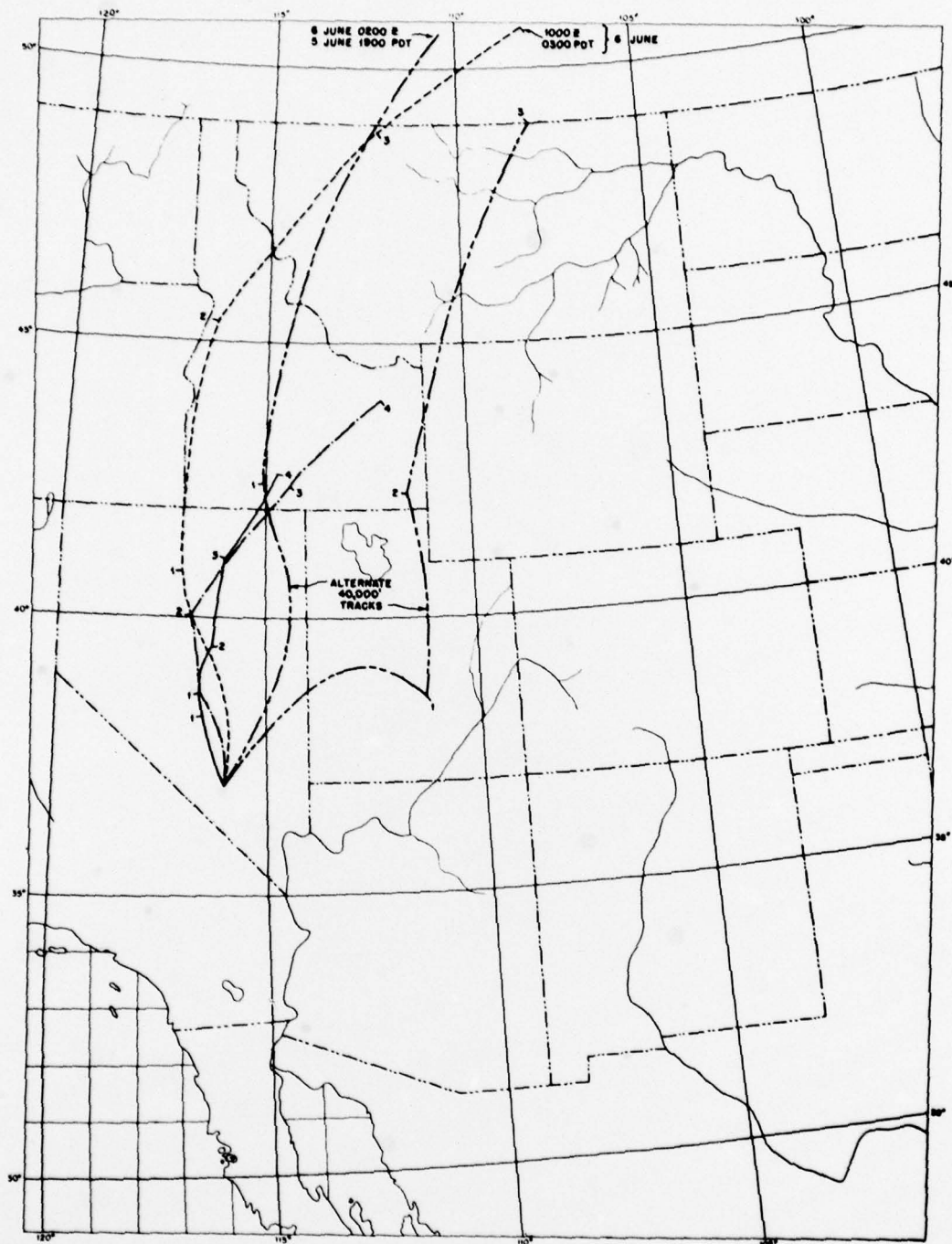


Fig. 51—Cloud trajectories for Tumbler-Snapper 8. —, 10,000-ft trajectory; - - - - , 20,000-ft trajectory; - - - - , 30,000-ft trajectory; - · - · - , 40,000-ft trajectory. 1, 1800Z 5 June (1100 PDT 5 June). 2, 0000Z 6 June (1700 PDT 5 June). 3, 0600Z 6 June (2300 PDT 5 June). 4, 1200Z 6 June (0500 PDT 6 June).

**UNCLASSIFIED**

~~SECRET - SECURITY INFORMATION~~

## **DISTRIBUTION**

Copy

### **ARMY ACTIVITIES**

Assistant Chief of Staff, G-3	1
Assistant Chief of Staff, G-4	2 - 3
Chief of Research and Development, Office, Chief of Staff	4
Chief of Ordnance	5
Chief Chemical Officer	6
Chief of Engineers	7
Chief Signal Officer	8
Chief, Army Field Forces	9
Commandant, AA&GM Branch, Artillery School, Fort Bliss	10
Commandant, Army War College	11
Commandant, Command and General Staff College, Fort Leavenworth	12
Operations Research Office (Johns Hopkins University)	13 - 14
Commanding Officer, Signal Corps Engineering Laboratory, Fort Monmouth	15
Commanding Officer, Ballistic Research Laboratories	16
Commanding Officer, Army Chemical Center, Chemical and Radiological Laboratory	17
Commanding General, Army Chemical Center	18

### **NAVY ACTIVITIES**

Chief of Naval Operations, OP-36	19
Chief, Bureau of Ordnance	20
Chief of Naval Research	21
Commander, U. S. Naval Ordnance Laboratory (Aliex)	22
Director, U. S. Naval Research Laboratory	23
Commanding Officer, U. S. Naval Radiological Defense Laboratory	24
Commanding Officer, U. S. Naval Medical Research Institute	25
Commandant of the Marine Corps	26
Commander, Fleet Training Center, San Diego	27
Commander, Fleet Training Center, Norfolk	28

### **AIR FORCE ACTIVITIES**

Assistant for Atomic Energy	29
Director of Operations, Operations Analysis Division	30

~~SECRET - SECURITY INFORMATION~~

**UNCLASSIFIED**

UNCLASSIFIED

**SECRET**  
**SECURITY INFORMATION**

Director of Intelligence (Phys. Vn. Branch, Air Targets Division)	31
Commanding General, Air Research and Development Command	32 - 33
Commanding General, Air Materiel Command	34 - 35
Director of Research and Development	36
Commanding General, Air University, Maxwell Air Force Base	37
Commanding Officer, Special Weapons Center, Kirtland Air Force Base	38 - 39
Commanding General, Wright Air Development Center	40
Commanding General, Air Force Cambridge Research Center	41
RAND Corporation	42
RAND Corporation (Griggs)	43

**AFSWP ACTIVITIES**

Chief, Armed Forces Special Weapons Project, Washington	44 - 52
Commanding General, Field Command, Armed Forces Special Weapons Project, Albuquerque	53 - 58

**DEPARTMENT OF DEFENSE**

Chairman, Research and Development Board	59
Director, Weapons System Evaluation Group, Office of the Secretary of Defense	60
Executive Director, Committee on Atomic Energy, Research and Development Board (Beckler)	61

**ATOMIC ENERGY COMMISSION**

Division of Military Application	62 - 64
Los Alamos Scientific Laboratory, Report Library	65 - 69
Sandia Corporation	70 - 89
Technical Information Service, Oak Ridge (surplus)	90 - 108
University of California Radiation Laboratory, Livermore	109
Weapon Test Reports Group, TIS	110

UNCLASSIFIED

64  
**SECRET**  
**SECURITY INFORMATION**